AMBLYOPIA: DIAGNOSIS AND TREATMENT MADE SIMPLE
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Course Goals
- To improve practitioners comfort in examining pediatric patients
- To learn about the different types of amblyopia
- To review the exam techniques useful in examining patients with decreased visual acuity
- To be able to diagnose amblyopia
- To be aware of current treatment options for amblyopia

Why is Amblyopia Scary?
- Children don't always provide good history
- Parents surprised that a child cannot see from one eye
- Practitioners don't want to miss bigger pathologies
- Practitioners don't want to deal with patching/atropine/therapy

Amblyopia Definition
- AOA - “poorer than 20/20 in the absence of any obvious structural anomalies or ocular disease”
- Inability for clear or aligned retinal image within the first 8 years of life

Why Does it Matter?
- 2.3% of the population
- Public Health
  - 17X greater risk of losing VA in better eye
  - 3X greater risk of losing VA in better eye

Functional Amblyopia Categories
- Refractive
- Isoametropic (1-2%)
- Anisometropic (37%/5%)
- Strabismic (38%/82%)
- Refractive & Strabismic (24%/13%)
- Image Degredation
  - 90% aniso/strab/combo

Refractive Amblyopia
- Isoametropic
  - AOA AAO (ages 2+)
  - Hyperopia > +3.00
  - Astigmatism > 2.50
  - Average VA 20/50
- Anisometropic
  - Hyperopia > 1.00 >2.00
  - Myopia > -3.00 same
  - Astigmatism > 1.50 >2.00
  - Average VA 20/60

Strabismic Amblyopia
- Due to early onset constant, unilateral strabismus
  - Average VA 20/74

Strabismic Amblyopia
- Esotropia
  - Accommodative
  - Hyperopia
  - High A/C A Ratio
  - Infantile
  - More likely unilateral
- Exotropia
  - More likely intermittent and alternating

Birch & Holmes. The clinical profile of amblyopia in children younger than 3 years of age. JAAPOS 2010;14:494-7
PEDIG. The clinical profile of moderate amblyopia in children younger than 7 years. Arch Ophthalmol 2002;120:281-7
Anisometropic/Strabismic Amblyopia

- Average VA 20/94

Brain Studies

- Decreased gray matter concentration in the lateral geniculate nucleus in human amblyopes. Barnes et al. IOVS 2010
- LGN less gray matter
- Altered Functional Connectivity of the Primary Visual Cortex in Subjects with Amblyopia, Drag K et al. Neuroplasticity 2013
- Primary visual areas of inferotemporal lobe and posterior cerebellum
- Central nervous system deficit
- Depth of amblyopia?
- Stereopsis?

Image Degredation

- Physical obstruction in line of sight
- Cataract
- Ptosis
- Hyphema
- Prolonged Patching or occlusion?
- Unilateral or bilateral
- Bilateral congenital cataracts - Sensory Nystagmus
  - If image not cleared by 2 months
  - Severe amblyopia 20/200 or worse
  - Acquired opacities > 6 months old no nystagmus

Organic Amblyopia

- Due to structural anomalies of the eye or brain independent of sensory input
- Optic atrophy
- Optic nerve hypoplasia
- Macular scar
- Anoxic occipital brain damage

Strabismic Amblyope

- 15 year old F referred for amblyopia and strabismus treatment
- OD turns out
- Ret
  - OD -1.25 20/30-
  - OS plano 20/20
- Cover Test
  - Distance 45
  - Near 8 RX(T)
- Stereopsis
  - 1/6 Randot shapes

Case History

- Chief Complaint
- Patient's past medical history
- Medical History
- Observations
  - Eye turn/Head tilt
    - Location
    - Onset
    - Duration
    - Frequency
    - Diplopia
- Neurological signs
- Trauma
- Prior Treatment

Risk Factors

- Family history
- Systemic Conditions
  - Prematurity/LBW/ROP
  - CP
  - MR
  - DS
Exam Sequence
- History
- VA
- Alignment
- Refraction
- Appearance
- Motility
- Sensory/Recess/Stereopsis
- VF
- Pupils
- Refractometry
- Retinoscopy
- Accommodation
- Color Vision
- Health
- Dilation/IOP

Visual Acuity Testing
- Contour interaction
  - First and last letters of the chart easier
  - Easier single letter

Language Factor
- Does the child have poor vision or is it that the child doesn’t know his/her letters?

Able to test with acuity chart
- Allen Pictures
- Tumbling E
- Lea Symbols
- HOTV
- Snellen

Allen Pictures

Tumbling E

Lea Symbols

HOTV

Too Young to Test/Non Verbal
- Forced Preferential Looking
- Teller Acuity Cards
  - $2200
- Cardiff Cards
  - $1470
- Advantages
- Disadvantages

Image Courtesy of Marilyn Vricella, OD
Too Young to Test/Non-verbal
- CSM
- Induced tropia test
- F&F
- Blinks to light
- Blink to threat

CSM
- Central
  - Cover 1 eye is light centered on pupil
- Steady
- Nystagmus
- Maintained
  - If tropic can they hold fixation with tropic eye for 5 seconds after removing cover from fixating eye

Induced Tropia Test
- Use a a near target
- 1.0-1.2 prism base down in front of one eye
- Watch to see if the eye shifts to maintain fixation
- If one eye always fixes on the target this suggests poor acuity in the other eye

Visual Acuity Dos and Don’ts
- Do patch
  - Band-aid type
  - Other types
- Do watch for peeking/posture
- Don’t use hands

The Peeker?
- 4 y/0 September First eye exam
  - VA 20/20 OD/OS 20/20
- November had eye injury saw another OD
  - VA 20/20 OD, 20/200 OS (Allen Pictures)
- Cylc Ret
  - +3.00 OD, +9.00-1.50x170 OS
- Dilatation
  - Optic nerve: “nasal elevation, crowded”

The Peeker?
- 2nd Opinion
  - VA 20/20 OD, 20/150 OS
  - PERRL (-) RAPD
  - Cover Test: Ortho D/N
  - Stereopsis: suppression
  - Worth 4 Dot: suppression OS
  - Ret: +5.50-1.00x30 OD, +7.50-3.00x165

Dilation
- Why is this important?
- MRI of brain and orbits
- Results: “Minimal bulging of the bilateral optic discs. These findings can be seen in both papilledema or pseudopapilledema. Correlation with CSF pressure could be helpful.”
Near Visual Acuity

- Use appropriate test distance
- If not decreased at distance and near, it is not amblyopia!

Strabismus

- **Constant unilateral strabismus**
  - Cover Test
  - Distance
  - Near
  - Hirschberg
    - 1mm displacement = 20-25 prism diopters
    - Nasal (+)
    - Temp (-)
    - Bruckner

Hirschberg

Comitancy

- 9 positions of gaze
- Difference of 4 prism diopters
- A Pattern Strabismus
  - More Exo in upgaze relative to downgaze
- V Pattern Strabismus
  - More Exo in upgaze relative to downgaze

Monocular Fixation Status

- **Visuoscropy**
- Monocularly
- Note if fixation is steady, unsteady, central or non-central (nasal, temporal, superior, inferior)
Microtropia

- A small angle strabismus (<4°) where there is no movement on cover test and the patient fixates eccentrically
- Tests
  - Stereopsis
  - Worth 4 Dot
  - 4 Base out

4 Base Out Test

- Done binocularly
- Place a BO prism before the eye.
- Patients will fail this test if any type of central suppression (macular disease)

4 Base Out Test – normal

4 Base Out Test - Positive

Sensorimotor Fusion

- Randot Stereopsis or Lang Stereopsis
- Worth 4 Dot

Ocular Motility Testing

- Ensure no restrictions of gaze which may be indicative of a cranial nerve palsy
- Versions & Ductions
- CN VI & ET
Visual Field Testing
- Attempt at least a gross test
- Automated if indicated

Pupillary Response
- Can get RAPD with amblyopia but need to rule out other etiology

Refractive Amblyopia
- Isoametropic
  - Hyperopia: > +3.00
  - Myopia: > -8.00
  - Astigmatism: > 2.50
  - Average VA: 20/50
- Anisometropic
  - Hyperopia: >1.00 >2.00
  - Myopia: > -3.00 same
  - Astigmatism: > 1.50 >2.00
  - Average VA: 20/60

Astigmatism
- Auto-refraction/Keratometry
- Corneal Topography

Accommodation
- Reduced in amblyopic eyes
  - "Our results suggest that amblyopic eyes do not accommodate as well as non-amblyopic eyes"
- Push-Up Amplitude
- Pull-Away Amplitude
- Minus Lens
- Norm: 1.5-1/4 age
  - +2

Refractive Error

<table>
<thead>
<tr>
<th>Refraction</th>
<th>50% incidence</th>
<th>100% incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyperopia</td>
<td>+2.00 or greater</td>
<td>+3.50 or greater</td>
</tr>
<tr>
<td>Myopia</td>
<td>5.00 or greater</td>
<td>6.50 or greater</td>
</tr>
</tbody>
</table>

(Tanlamai & Goss '79)

Color Vision
- Color vision – OU versus monocularly

Thorough Ocular Health
- IOP
- Dilation
- Photos/Retinal Imaging
- Electrodagnostic
Infant Assessment
- History by parent
- VA
- CSM
- Alignment: Hirshberg/Bruckner
- Motility
- Doll’s Head
- Vertical Prism Test (Induced Tropia Test)
- Pupils
- Retinoscopy
- Health

Toddler Assessment
- History
- VA
- Alignment: Cover Test or Hirshberg
- Motility
- Stereopsis
- Pupils
- Retinoscopy
- Refraction
- Health

School Aged Assessment
- History by patient/parent
- VA
- CT
- Stereopsis
- Retinoscopy/Refraction
- Health
- Color Vision

All of the Above Normal and Child Won’t Read
- Try Tricks
- Follow Up in 2-3 months
- Refer for consult neuro v. retina

Try Tricks
- Start at 20/10 line and work up to 20/20
- “Magic Glasses”
  - +8.00 alone, then -8.00 alone, then both together “extra strong”
  - Start with 20/10 line then 20/20 for the plano
- Low plus glasses +0.12 OU and retest

Dx: Malingeringer
- 13 year old White Female seen for “several” failed school vision screenings in November
- Seen for eye exam in April by eye doctor who said “glasses would not help” and referred to neuroophthalmologist
- Mom seeing another OD for a 2nd opinion in June

Other history
- Patient complains that vision has been decreasing since September
- Mom unhappy with diagnosis by neuroophthalmologist
- Mom does not feel patient wants glasses but does hold things close
- Patient’s dad ordered MRI of brain
- Mild heterogeneous enhancement of pituitary within normal

Neuro-ophthalmology
- Exam notes reviewed
- Exam found 20/40+2 OD, 20/125 OS, No APD, CVF within normal limits, Color 9/10 OU (HRR) Stereo (+)
- ny, 5/3 A, 9/9 C , 4 BU test sees 20/30 letters x 2 same clarity
- Non-organic vision loss
- D/W parents and reassure patient

2nd Opinion Exam
- VA 20/50 -2 OD, 20/70-2 OS
- PERL (-) RAPD
- VF: FTFC OD/OS Red cap: nasal duller each eye
- TAP: 19 mmHg each eye
- Stereopsis 7/9 circles
- Worth 4 dot: Suppression OD at distance, fusion at near
- Keratometry: no distortion
- Color 9/11 OB/OS
- Dilation revealed RPE changes perimacular (+) FR
If this is amblyopia what does research say to do?

Isoametropic Amblyopia

- Ages 3-10
- VA 20/40 - 20/400
- Hyperopia ≥ 4 diopters and/or
- Astigmatism ≥ 2 diopters
- No myopia > 6.00
- Initial VA 20/63
  - 79% within 2 lines VA difference
  - 73% 20/25 OU at 1 year


Case Report

- 6 yo male failed vision screening
  - Parents think eye turn in
  - VA 20/70 each eye sc
  - Stereopsis 50" Wirt
  - Cover Test
    - Orthophoria
    - Ret OD +4.50  OS +5.00
    - Cyclo OD +5.50  20/40  OS +5.50 20/40
  - Treatment Plan

Case Report – Follow Up

- “Loves Glasses”
- VA 20/25+2 each eye
- Stereopsis 25” Wirt
- Cover test
- No change

Amblyopia Treatment Studies

- Pediatric Eye Disease Investigator Group
  - Multi-Center
  - Randomized Clinical Trials
  - Treatment for Amblyopia
    - Strabismus
    - Anisometropia
    - Both
    - No Myopia > -0.50
    - Interacuity difference 3+ lines

Amblyopia Treatment Studies (ATS)

- ATS 1 – A Randomized Trial of Atropine vs Patching for Treatment of Moderate Amblyopia in Children (Arch Ophthal, Mar 2002, 268-78)
  - Adhesive Patch v. atropine qd x 6mos
  - Ages 3-7
  - VA 20/40-20/100
  - 79% patch, 74% atropine success

Retinal Specialist

- VA 20/30+3, 20/80+1
- Cone-rod dystrophy
Amblyopia Treatment Studies (ATS)

- A Randomized Trial of Atropine vs Patching for Treatment of Moderate Amblyopia Follow up at 10 years Arch Ophthalmol 2008;126:1039-1044
  - 89% received amblyopia treatment
  - 88% no treatment in prior year
  - Mean VA 20/32
  - Amblyopic eye 20/25+ in 46%
  - Younger age (<5) better outcome
  - Point: Can get Regression

Follow Up 15 Years

- JAMA Ophthalmol 2014
  - 6% had treatment ages 10-15
  - Mean VA 20/25
  - Amblyopic eye 20/25+ in 60%
  - Younger age (<5) better outcome

Amblyopia Treatment Study (ATS)

- ATS 2- A Randomized Trial of Patching Regimens for Treatment of Moderate Amblyopia in Children (Arch Ophthalm, May 2003, 603-11)
  - 2 hour v. 6 hour patching with 1 hour of near activities
  - 4 months
  - Ages 3-7
  - VA 20/40-20/80
  - 62% success
  - Point: Moderate amblyopia patch 2 hours

Amblyopia Treatment Study (ATS)

- ATS 2C - Risk of Amblyopia Recurrence After Cessation of Treatment (JAAPOS, Oct 2004, 420-428)
  - Age < 8 years
  - VA worse than 20/40 at start of treatment with 3+ line improvement during treatment
  - Follow up 52 weeks
  - Overall recurrence 24%
  - Greater if 6-8 hours abruptly discontinued

Factors Associated with Recurrence of Amblyopia on Cessation of Patching (Ophthalmology 2007;114:1427-32)

- Age < 8 years
- Max 2 hours patching
- Max 8 hours patch weaned v. non-weaned
- Factors:
  - VA at time of patching cessation, not initial VA
  - Greater VA improvement during treatment
  - Prior recurrence

Amblyopia Treatment Study Results

- ATS 3- Randomized Trial of Treatment of Amblyopia in Children Aged 7 to 17 Years (Arch Ophthalmol, Apr 2005, 437-47)
  - Refractive or strabismic amblyopia
  - VA 20/40-20/400
  - Optical correction or treatment
  - 24 weeks

- Older Group (13-17)
  - 20/25+
  - 1% Optical Correction
  - Severe Amblyopia
  - 20/30+
  - 1% Optical Correction

- Moderate-Amblyopia
  - 20/25+
  - 1% Optical Correction

- Younger Group (7-12)
  - 20/25+
  - 1% Optical Correction
  - Severe Amblyopia
  - 20/30+
  - 1% Optical Correction

- Moderate Amblyopia
  - 20/25+
  - 1% Optical Correction

- Amblyopia Treatment Study (ATS)

- Amblyopia Treatment Study (ATS)

- Amblyopia Treatment Study (ATS)
Amblyopia Treatment Study - Results

- Overall 2 lines improvement in 25%
- 7-12 year old double response with treatment
- 13+ no significant difference with optical correction alone or treatment unless no prior treatment
- 47% responder in previously untreated

Amblyopia Treatment Study (ATS)

  - Stable, residual amblyopia after 2 hours of daily patching + 12 weeks
  - VA 20/32-20/160
  - VA improvement after 10 weeks
  - 2 hours – 0.5 lines
  - 6 hours – 1.2 lines

  - Ages 3 to < 10 years
  - Moderate amblyopia 20/40-20/80
  - VA 20/40-20/60 – Use Filter 0.3
  - VA 20/60 – Use Filter 0.2
  - Satisfy (filter)
  - Stabilizes with follow-up if no VA improvement
  - Patch 2 hours/day
  - No significant VA change @ 24 weeks
  - 1.9 less Bangerter, 2.5 less patching

- ATS 4 - A Randomized Trial of Atropine Regimens for Treatment of Moderate Amblyopia in Children (Ophthalmology 2004;111:2076-85)
  - Daily versus weekend atropine x 17 weeks
  - Ages 3-7
  - VA 20/40 - 20/80
  - Improvement 2.3 lines, about 50% 20/25+

- ATS 5 – Treatment of Severe Amblyopia with Weekend Atropine: Results from 2 Randomized Clinical Trials (JAAPOS 2009;13:288-63)
  - VA 20/125-20/400
  - Trial 1: Atropine + Plano Lens vs. Atropine + Full Rx.
    - Ages 3-6
    - VA after 18 weeks approximately 5 lines improvement
    - VA 20/40-20/80 39% plano, 21% full Rx.
  - Trial 2: Weekend Atropine vs. Patching 2 hours/day
    - Ages 7-12
    - VA similar after 17 weeks, approximately 1.7 lines improvement
    - Residual amblyopia in 97.5%

- ATS 6 – A Randomized Trial of Near Versus Distance Activities While Patching for Amblyopia in Children Aged 3 to Less than 7 Years. Ophthalmology 2008;115:2071-8
  - VA 20/40-20/400
  - Improved 2.6 lines distance, 2.5 lines near
  - 2 hours of patching can improve VA in severe amblyopia

  - Ages 3 to < 8 years
  - Stable, residual amblyopia after 2 hours of daily patching x 12 weeks
  - VA 20/32-20/160
  - VA improvement after 10 weeks
  - 2 hours – 0.5 lines
  - 6 hours – 1.2 lines

  - Ages 3 to < 10 years
  - Moderate amblyopia 20/40-20/80
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  - Stable, residual amblyopia after 2 hours of daily patching + 12 weeks
  - VA 20/32-20/160
  - VA improvement after 10 weeks
  - 2 hours – 0.5 lines
  - 6 hours – 1.2 lines

What do we know

- Patching, atropine and filters can improve VA
- VA gains are maintained but better when younger
- Patching better than no patching
- Patching does not need to be full time
- 2 hours moderate
- 6 hours severe
- Can increase if VA not improving
- Teenagers are not too old to treat
- Don’t need to start patching immediately
- Atropine 2 times a week ok instead of patch
### Other Findings in Amblyopia

- Decreased fine motor skills
- Decreased eye-hand coordination skills
- Slow eye movements
- Decreased facial recognition (amblyopic eye)
- Deficits in luminance perception (dichoptic stimuli)
- Increased luminance to amblyopic eye
- Decreased contrast sensitivity
- High spatial frequencies

### Summary

- Remember that amblyopia is also a syndrome not only of decreased VA but spatial distortion, poor accommodation, decreased contrast sensitivity, poor tracking and poor monocular fixation

### Treatment Plan

- **Optimal Correction**
  - Refract if deviation > D
  - Cycloplegic minus 1.00 – 2.00 diopters
  - Full cylinder
  - Consider CLs > 5 diopter difference
  - Follow up 8-12 weeks VA check

### Contact Lenses for Amblyopia?

- Caution about vision loss
- Infection in good eye
- Injury to good eye
- When amblyopia treatment may consider polycarbonate lenses over CLs
- When older do not recommend if VA worse than 20/40 in amblyopic eye

### Case

- **3yo 4mo**
  - intermittently turns in for past 6 mo
  - No FEH strabismus
  - FT; 8lb 6 oz; no complications
  - Normal developmental milestones
  - HOTV DVA
    - OD 20/200
    - OS 20/60+
  - 30° Alt ET (OS fixation preferred)
  - Dry Ret
    - OD +6.50
    - OS +7.00
  - No stereo

### Treatment

- **OD +6.00 sph OS +6.50 sph polycarbonate FT wear**
- **RTC 8 wks**

### Occlusion Options

- **Patching**
  - Band aid type
  - Problems
  - Solutions
  - Cloth patch
  - Problems
  - Solutions
  - String patch
  - Problems
  - Solutions

### Occlusion Options

- **VA 20/80 or worse – patch 2-6 hours/day**
- **VA 20/70 or better – patch 2 hours/day**
- Reassess 8-12 weeks
- If improving continue until stable 2-weeks
- May need to increase patching or change occlusion method

### 6 week f/u

- Rx worn FT X 3 wks; patient likes glasses; no eye turn cc
- DVA cc
  - OD 20/30-2
  - OS 20/30-2
- NVA cc
  - OD 20/30
  - OS 20/30
- Stereo F Resp
- DCT ortho
- NCT flick esophoria
- RTC 3 mo
Other options

- Atropine 1%
- 2 times a week
- Can instill a few days apart
- Can instill when asleep
- Can check pupils to see if working/compliance
- Educate parents

Atropine Penetration for Amblyopia

Definition/Explanation:

Atropine ophthalmic drops come in a small dropper bottle with a red cap. This medication has two effects: 1) it causes the pupil to enlarge and 2) it relaxes the focusing power of the eyes resulting in blurred near vision. The blurring effects only last a day or so, but the pupil might remain dilated for several days to a week. The child might complain of light sensitivity which can be helped with a hat or sunglasses (or just getting used to it). Children who have amblyopia due to a crossed eye (esotropia) should begin using their “lazy eye” and the “good” eye might turn in. This is the desired effect, especially when looking at something close.

The child’s teacher should be informed about this therapy.

Medication/Administration:

- Put the eye drop into the right / left eye in the morning.
- Before applying the drop, wash your hands.
- Position the child with his head back and looking up or lying down and looking up.
- Gently pull the lower lid down with your forefinger, having the child look up toward the ceiling.
- Squeeze only one drop into the inside of the lower lid.
- Have the child gently close the eyes.
- Apply light pressure to the corner of the nose for 1 minute.
- Carefully wipe off excess drops and discard tissue.
- Wash your hands again.

Side Effects:

Rarely, a child may experience a reaction to atropine. This reaction may cause a reddened or flushed face usually accompanied with a fever. If this occurs, do not be alarmed. The flushed face and fever should go away in a few hours. If the child quickly returns to normal, resume the use of the medication. If the reaction occurs again or if the child experiences an extended reaction or any other problem (upset stomach, agitation, or rash), call the office at #.

Safety and Precautions:

- Store all medications in a safe place. Keep the atropine out of the reach of children (even when discarding the "empty" eye dropper bottle). It is dangerous to use the medication for any other purpose.
- Keep medication out of the untreated eye.
- Always wash hands before and after each use.

Activities When Patching

- Fine Motor Type Activities
  - Age appropriate
  - Draw
  - Color
  - Leggos
  - Pop Bubble
  - Flashlight Tag
  - Puzzles
  - Video Games
  - Wii
  - Sort

Groffman Tracing

- Hidden pictures/words
- Form tracing
- Visual search

Michigan Tracking

- Encourage Stereopsis (if they have it)
- Binocular
- Ball in hole activities
- 3-D movies
- Range of motion

Other options

- Bangerter foils
- Alternatives?
- Clear contact paper
- Nail polish
- Medical tape
- Check VA through occlusion method
**Vision Therapy**

- 16 week trial
  - Recruitment
  - Ages 7-13
  - Stereopsis
  - Therapy
  - Accommodation
  - Vergence
  - Antisuppression
  - Good adherence
  - Enrollment

**Rewards**

- Patching/Atropine Calendar
- Parent Education
- Treasure Chest

**Failure in Amblyopia Treatment**

- 15-50%
- Reasons
  - Delay?
  - Compliance?
  - Inadequate Treatments?
  - Anomalies?
  - Optic Nerve
  - Macular Thickness
  - Gaze

**New Frontiers in Amblyopia Treatment**

- Theme: Amblyopia occurs when a mismatch between the images to each eye (abnormal BINOCULAR interactions) BUT treatment is MONOCULAR
- Perceptual Learning
- Video Games
- Levodopa
- Brain Stimulation

**Perceptual Learning**

- Repeated practice on demanding tasks show improvement that generalizes to other tasks
- Teach amblyopic eye to make fine discriminations
- Improvement in adults 1-2 lines
- fMRI changes
- Concerns
  - Time for treatment
  - Boredom
  - Children

**Perceptual Learning**

- Treat binocular dysfunction as primary
- Treat monocular VA deficit as secondary
- How:
  - Reduce contrast to “good eye”
  - Increase over time until both eyes match
- Improvement 15-20 hours
- Improvement 1-4 lines
- Birch et al 2013. JAAPOS, vol 17

**Video Games**

- Dichoptic play of Tetris
  - After 8 weeks – VA improved 2 lines
  - After 10 hours – stereopsis improved by factor of 4
  - Patching group – no improvement

**Levodopa/Carbidopa – ATS 17**

- Ages 8-18
- VA 20/50-20/400
- Prior Treatment
- 1-2 doses with daily occlusion
- Results
  - 4 letters averaged in low dose, 13% improved 10+
  - 6 letters averaged in high dose, 29% improved 10+
- Side effects
  - HA, URI, Rash

**Non-invasive Brain Stimulation**

- Transcranial Magnetic Stimulation (rTMS)
  - Magnetic field is called from wire placed over cortical area to be stimulated
  - FDA for depression
  - Left prefrontal cortex
- Study on 9 adults
  - Improved contrast thresholds in 66% by 40%
  - Controls showed improvement in contrast for non-dominant eye, decrease for dominant eye