**Advanced Amblyopia Treatment**

**for better results**

Dan L. Fortenbacher, O.D., FCVD

---

**Why Amblyopia?**

- The most common form of unilateral vision loss
- Affects over 10,000,000 people in the US alone
- It is universally accepted as a product of a binocular vision disorder
- Yet the “gold standard” for treatment is based on monocular occlusion
- But, a surge of new research is validating a binocular model of treatment as superior to occlusion therapy which could make this the new standard of care

**…or will it?**

---

**The beginnings of our traditions in amblyopia**

- 1700’s Charles de Saint-Yves notion that visual deprivation at an early age resulted in changes in the brain and defective visual perception
- Late 1800’s–early 1900’s Javal and Worth suggested the presence of a ‘sensory obstacle’, causing arrest of development of visual acuity. Worth coined “amblyopia of arrest” and “amblyopia of extinction.”
- 1960’s: Hubel and Wiesel anatomical and physiological research on cats and monkeys confirming a critical period of visual development; thus translated to be also true for humans.

---

**Traditional Amblyopia Definition**

- Amblyopia is a decrease in visual acuity, usually in one eye.
- It persists after the correction of the refractive error or removal of pathological obstacle to vision (e.g., cataract) and no organic cause can normally be found
- The general estimate of the prevalence of amblyopia hovers around 3.5%
- This developmental anomaly is mainly monocular and caused by either misalignment of the eyes (strabismus), a refractive error (anisometropia) and/or a form of deprivation (ex: infantile cataract)
Amblyopia equals poor visual acuity

Reduced VA in one eye
- Mild: 20/40 or better
- Moderate: < 20/40 – 20/80
- Severe: < 20/80 - 20/200

Traditional Amblyopia Etiology and Treatment

- A disruption in binocular vision during the “critical period” in visual development up to 6 years of age
- Tx: Occlusion of the better eye

Traditional “Critical Period model” requires early treatment

- “Early treatment can reduce or completely reverse the effects of early abnormal visual experiences, whereas treatment later in the critical period is less effective”

Traditional Amblyopia – Patient Anatomically Monocular

- “These conditions ... interfered with the architecture of young child’s developing brain”
- Leads to a framework of assumptions that amblyopes, even within the critical period are anatomically monocular, lack the capacity for functional binocularity

This has lead to the traditional evidence-based “gold standard” for amblyopia treatment

- Spectacle correction (when there is uncorrected refractive error)
- Wait 2-3 months to see what happens
- followed by full to part-time patching and/or atropinization of the fellow eye
- Only if caught before age 9-10 years!

PARADIGMS OF TREATMENT
Paradigms of Treatment

Online News Story

Quotes from the comments

• “I have lazy eye too. To think it is so easy to treat before the age of 5! That really makes me mad!!”
• “I am 21, and at times I wonder how it feels to see with both eyes.”
• “I have amblyopia 😞 I’m over the age of 10… I want it gone!”

National Institutes of Health (NIH)

Treatment
– Patching, surgery, and glasses

Prognosis
– Treated before 5 usually will recover almost completely, although may have problems with depth perception
– Delaying treatment can result in permanent vision problems.
  • “After age 10, only partial recovery of vision can be expected.”

National Institutes of Health - NIH

“After age 10, only partial recovery of vision can be expected.”


• "No compelling evidence that treatment is beneficial clinically for older (over age 10) children with amblyopia”

The standard treatment paradigm

• Full ophthalmic correction (refractive amblyopia)
• Wait for 2-3 months
• RTO, if amblyopia persists begin occlusion
• Occlusion Therapy
  – Dosage protocols
    • Full time patching
    • Part time patching
    • Monitor periodically

Occlusion methodology

• Direct complete occlusion
  – Variety of eye-patch examples
• Partial Occlusion
  – Optical-defocus
  – Bangerter foils – graded occlusion (ATS-10)
• Medicated Occlusion – Atropine (ATS-1,
  ATS-4, ATS-8, ATS-9)

Evolving paradigms expand “sensitive” period and decrease dosing

• PEDIG ATS-2A, found duration of occlusion could be reduced to 2-6 hours per day with equal or better outcomes compared to constant occlusion
• PEDIG ATS-3 research found some improvements up to age 17
• PEDIG ATS-5 found occlusion therapy plus visual motor activities to be better
  • Patching and atropine

• Emily’s Story
Emily’s Key Findings

- Age 17 when referred to us by her primary care OD
- Anisometropia:
  - OD: plano, OS: +2.50
- BVA OS: 20/40
- Suppression OS (Worth 4-dot)
- Stereopsis NONE (Wirt: dist and near)
- DX: 1. Refractive Amblyopia (OS), 2. Stereo Blind

“I just didn’t know what good vision was like…”

Amblyopia’s impact

- Family
- Parents
- Individual

Amblyopia’s impact on quality of life: a systematic review

J Carlton and E Kaltenthaler, Eye (2011) 25, 403-413; Health Economics and Decision Science (HEDS), School of Health and Related Research

- In 2010 a systematic review of 1,876 papers on Amblyopia and filtered out duplicates to 632 acceptable articles
- The best 35 articles were selected based on strict scientific criteria with an emphasis on Quality of Life Assessment measures

Results of the Amblyopia and quality of life systematic review

- The implications of amblyopia and/or its standard methods of treatment fell into four broad categories:
  - Impact on family life
  - Social interactions
  - Activities
  - Feelings and behaviors

Impact on Family Life

- Standard amblyopia treatment resulted in:
  - Increased stress and anxiety for the parent
  - Negatively impacted care giver-child relationships
  - Other relationships within family also affected
    - Siblings teased or bullied the child in treatment
    - The increase in parent attention associated with the treatment
Social interactions

- Bullying and interactions with peers is widely documented as a result of the treatment
- Feelings of isolation and noting differences between others were also documented

Activities

- Frequently reported implications was the impact of amblyopia on career choice and educational attainment
  - Immediate impact on school activities during standard treatment (occlusion while at school)
  - Long term impact on adult hood
- Impact on daily living activities was well documented

Feelings and behavior

- Feelings of low self-esteem and negative self-image commonly reported due to amblyopia lone or due to it’s treatment
- Depression
- Frustration
- Embarrassment

Recognized limitations to occlusion therapy

- Acuity improves but will often regress when patching is discontinued
  - 54% (age 3-7), 80% (age 9-12) with residual amblyopia (≤20/32)*

Recognized Risk factors associated with Occlusion Therapy

- Psycho-social
  - Bullying, teasing
- Emotional
  - Frustration
  - Anger
  - General unhappiness
- Danger in playing sports, crossing streets, riding bicycle, operating motorized vehicles or machinery
- Difficulty functioning in classroom or other activities in daily living
Recognized pitfalls to occlusion therapy

- Poor compliance
- Patient drops out of treatment
- Poor results

Amblyopia most worn out tradition

- The language used to communicate the condition to the public
- Laying a guilt trip and fear on the parent to use better parenting skills and discipline to foster patient compliance in their children

Amblyopia pejoratives

- Lazy eye, weak eye, bad eye
- Noncompliant, uncooperative child
- Penalize the good eye

Lazy eye

Amblyopia judgments

What other health care condition associates “lazy” with the disease?

Good eye vs Bad eye

Penalize (“to punish”) the “good eye”, coined in by J.B. Weiss in 1968 referring to atropinization

Has this reference of judgment factored into the way doctors and the public have viewed this serious visual disorder?
Amblyopia Dogma

- If acuity is not improving patch longer
- A patient must try harder

Amblyopia Apathy

- You’ve got one good eye...protect it, sorry!
- Can’t help it if your child won’t comply with wearing a patch, sorry!
- After age 10 not much else we an do, sorry!
- It’s just the nature of lazy eye even after patching it can get lazy again, sorry!

Amblyopia fact or myth?

1. Is Amblyopia treatable only if caught before age 10?
2. Is Amblyopia a disorder that creates a monocular architecture in the brain preventing the capacity for binocular vision?
3. Is the only way to effectively treat Amblyopia by occlusion or atropine of the non-amblyopic eye?

Looking at the new research

- Amblyopia’s true impact on the visual brain
  - Visual processes
- Amblyopia’s true impact on the life of the person
  - Reading, real world visual motor tasks
- The emerging advanced treatment paradigm
  - The comparative speed of treatment
  - The absence of negative side effects
  - The sustainability of treatment

- Convincing evidence of abnormalities in structure and function within the “vision-for-perception” and “vision-for-action” cortex of people with amblyopia
• Convincing evidence of abnormalities in structure and function within the “vision-for-perception” and “vision-for-action” cortex of people with amblyopia

AMBYOPIA AND REAL-WORLD VISUOMOTOR TASKS

S Grant, MJ Moseley. Strabismus, 2011; 19(3) 119-129
Research review of eye-hand coordination, walking, driving, and reading skills of children and adults with amblyopia

• Amblyopes show a range of visuomotor impairments with the affected eye alone, but also in the binocular mode the amblyope is also slower and less accurate than normally sighted individuals

Eye hand coordination

• Amblyopic individuals, children and adults have significant deficits in movement, speed and accuracy
• Those who completed occlusion therapy in childhood with normalized “cured” VA in their amblyopic eye but have reduced stereo acuity (100-3000 arc secs) had significantly more spatial errors and eye-hand coordination vs controls

Amblyopia and Reading

• Deficits in micro eye movements contribute to reduced reading speed associated with central or total suppression of the amblyopic eye compared to the normal control subjects
• These deficiencies were apparent even when monocular testing with the non-amblyopic eye compared to the non-amblyopic controls

Walking

• While walking speed and gait are not affected by amblyopia, studies show stereo deficient amblyopes were more prone to trip when in obstacle-loaded environments
• More care should be taken by amblyopes to avoid obstacles in everyday walking
Driving
• Stereo deficient amblyopes showed to be less prone to road traffic accidents due to earlier braking tendencies
• However when stereo deficient subjects were engaged in driving in and around obstacles there was an increase risk of colliding with barriers.

Final conclusion
• A highly consistent finding is that children and adults with no clinically measureable stereoacuity exhibit the least accomplished real-world visuomotor skills.

Amblyopia’s impact on vision — more than acuity
• Dysfunction contrast sensitivity *
• Dysfunction binocular vision and stereopsis*
• Dysfunction in accommodation*
• Dysfunction in fixation*
• Dysfunction in vergence*
• Dysfunction visual information processing/reading*
• Dysfunction visual motor integration

*ATS-18 Background and summary

Why?
Given that occlusion therapy has a track record of:
• poor outcomes
• poor compliance
• significant risk factors for “side–effects”

Why is there not an outcry for something better?

Is there a critical period for the treatment for Amblyopia?

Perceptual learning in Vision Research
D. Sagi, Vision Research 51 (2011) 1552–1566
• Long-term sensitivity - improvement with visual tasks as a result of perceptual learning found in adults
• Neural plasticity is retained at an adult age, allowing flexibility in acquiring new visual skills when the need arises.
Perceptual Learning (PL) - Gaming

- Introduced idea of “gaming the visual system”
- Used adults to play Medal Of Honor

Plasticity in the adult human brain

- New clinical and experimental studies in both animals and humans provide evidence for neural plasticity beyond the critical period.
- The results suggest that perceptual learning and video game play may be effective in improving a range of visual performance measures and importantly the improvements may transfer to better visual acuity and stereopsis.

These findings, along with the results of new clinical trials, suggest that it might be time to reconsider our notions about neural plasticity in amblyopia.

Dennis M. Levi, Optometry and Vision Science, Vol. 89, No. 6, June 2012

Looking for answers

Dennis Levi, OD, PhD
Robert F. Hess, PhD, DSc
Eileen E Birch, PhD.
Jonathan M. Holmes, M.D.
Vivian Manh, O.D., M.S.

Limitations to Perceptual Learning?

- Specificity
- Boredom

What is Perceptual Learning in vision research?

- Visually stimulating and challenging activities usually in a computer based game.
- Often consist of:
  - Vernier acuity activities
  - Contrast sensitivity activities
  - Letter identification
  - Spatial frequency
  - Grating acuity
  - Motion coherence
Subjects: Amblyopes ages 18-58
- Play Medal of Honor: Pacific Assault with fellow eye patched
- Acuity measured every 10 hours for 40 hours
- All amblyopes improved!
- VA improvements from 13.44% to 20/20

Gaming the adult amblyopic brain?

Levi

- Occlusion (patching) is considered the “gold standard” method for treating childhood amblyopia
- But the dose response rate is slow (children 6-8 years) improvement occurs by a factor of 1.6 after about 240 hours of occlusion

Perceptual Learning plus occlusion yields a faster result by a factor of 8 in children 6-8 yrs old

perceptual learning improves response to treatment time -
Levi

Robert F. Hess, PhD
Director of Vision Research, Department of Ophthalmology
McGill University, Canada

- “For many years these deficits were interpreted within a framework assuming that amblyopes are anatomically monocular and lacked any functional binocularity”
- “Recent findings have provided strong evidence that amblyopes actually have an intact binocular infrastructure including binocular processes, even in the adult amblyope, however what appears to have been lost is only a sign of suppression under binocular viewing conditions”
Robert Hess, PhD

- "Current evidence indicates that suppression plays a primary role in both the binocular and monocular deficits"
- "Thus, treatment for the binocular problem involving suppression should be in the beginning of treatment process"
- "It appears that the real enemy in amblyopia is suppression"

Robert F. Hess, PhD
Director of Vision Research, Department of Ophthalmology
McGill University, Canada

- "It has also recently been shown that binocular functions can be restored in adults with amblyopia dichoptic training aimed at getting the two eyes to work together, suggesting that the binocular visual system also retains a considerable degree of plasticity even in adulthood."

Eileen E Birch, PhD.
Senior Research Scientist – Director, Crystal Charity Ball Pediatric Vision Evaluation Center

- "The usual treatment is to wear a patch over the “strong” eye, "to force the use of the amblyopic or weak eye"
- "That does work, but there’s been some research lately (suggesting) that’s not really the right approach,"
- "The condition often recurs after patching."
- "The treatment for amblyopia should also teach both eyes to work together...."
Example of iPad Anaglyph Tetris

Results of binocular iPad Study on Preschool Children
- Best results with >8 hrs in 4 weeks with binocular iPad therapy
  - 1 line improvement
  - Patching 2 hrs per day plus iPad binocular game, same outcome. Thus patching did not help!
- No change with:
  - Occlusion Therapy only
  - <4hrs in 4 weeks with binocular iPad
  - Sham therapy
  - No therapy

January 2015

Binocular treatment with iPad study
- N=50
- Ages: 4-12
- 4 Weeks

Binocular Treatment with iPad study
- Repeated binocular iPad game play significantly improved visual acuity in amblyopic children
- Visual acuity improvement occurred rapidly, and is stable for at least 3 months following the cessation of treatment.
- In addition to the efficacy and durability of this binocular iPad treatment, it is fun and engaging and results in better compliance than patching, at the same time imposes little risk for adverse psychosocial effects.

Newest PEDIG Amblyopia Treatment Study (ATS-18)
Newest PEDIG Amblyopia Treatment Study (ATS-18)

- Coordinating Center – Jaeb Center for Health Research, Tampa Florida
- Protocol Chairs
  - Vivian Manh, O.D., M.S., UW Medicine Dept of Ophthalmology, Seattle Children’s Hospital
  - Jonathan M. Holmes, M.D., Department of Ophthalmology, Mayo Clinic
- Study Objectives -
  - To compare the effectiveness of iPad binocular game play - 1 hour/day
  - versus Occlusion therapy - 2 hours/day
  - in children ages 5-13 and 13-17
  - Sample size 5 to <13 = 346, 13 to <17 = 166

- iPad Binocular Computer Game Treatment Group
  - iPad Hess Falling Blocks game (Anaglyph Tetris)
  - 1 hour per day x 7 days per week
- Patching Group
  - 2 hours per day x 7 days per week
  - Monitored over 16 weeks, q 4 weeks

- Study monitoring
  - Diplopia Questionnaire (research tool)
  - http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3895465/
  - Monocular Distance VA (goal 20/25)
  - Randot Stereoaucity (documented gains)
  - Ocular Alignment
  - Monitor q 4 weeks (4, 8, 12, 16)
  - Study duration 16 weeks

- Scheduled completion 2017!

- A neuro-developmental disorder
- Disruption in binocular vision
- Sensitive period
- Role of suppression
Since occlusion therapy typically

- Has limited results in acuity
- No improvement in binocular vision
- Psychosocial, emotional problems and negative factors
- How might we reduce or eliminate the need to rely on occlusion therapy and have a more effective treatment of amblyopia?
  - Including deficits in VIP and VMI?

Developing an Advanced Treatment model for Amblyopia

Amblyopia’s impact on vision ...
... more than acuity

- Dysfunction contrast sensitivity *
- Dysfunction binocular vision and stereopsis *
- Dysfunction in accommodation *
- Dysfunction in fixation *
- Dysfunction in vergence *
- Dysfunction visual information processing/reading *
- Dysfunction visual motor integration

*ATS-18 Background and summary

Begin with Evaluation

- Standard Snellen VA (Distance & Near)
  - Single Row
  - Single letter
- Contrast Sensitivity

Refraction

- Retinoscopy

- Subjective Refraction

Binocular Vision

- Binocular posture and alignment (9 cardinal positions)
  - Cover test
  - Maddox rod
- Sensory fusion
  - 1st degree - Simultaneous perception
    - Worth 4-Dot, etc
  - 2nd degree - Flat Fusion
    - Worth 4-Dot, etc
  - 3rd degree - Stereopsis
    - Distance and Near
Accommodation

- Mono Donders pushup
- Mono PRA (document VA target used)
- Mono NRA (document VA target used)
- +/-2.00 flipper (document VA target used)
- MEM - Dynamic Retinoscopy

Oculo-motor Assessment

Expanded Assessment

- Micro eye movements
  - KD (or DEM) Saccadic Eye Movement Test
    - Amblyopic eye vs Non-amblyopic eye

Ocular health

Prescribe lenses

- Least plus for maximum acuity with judicious balancing to minimize effect of aniseikonia and consider contacts and/or bifocals when appropriate

Expanded Assessment

- VIP - Amblyopic eye only
  - TVPS : VD, VC, VSR, VM, VSM, VFG
  - Jordan Left Right Reversal Test
Visual Motor Integration

- Beery VMI – Amblyopic eye only

Basic Reading Assessment

- Reading Tests – Amblyopic eye only
  - Test of Silent Word Reading Fluency (TOSWRF)
  - Oral Reading

where appropriate

- Visually Directed Gross Motor Assessment
- Visual Vestibular Integration
- Persistent Primitive Reflexes

Diagnosis… Treatment Plan

- Diagnosis influences duration
- Age is NOT a barrier!
- Prescribed Treatment
  - Office based
  - Home support

Treatment: Phase 1

Anti-suppression, early binocular vision development

- MFBF with VMI on SVI or WSF or with younger children use creative game applications of filters – plus detail recognition
- Anti-suppression eg. TBI lights, Eyetronix, etc
- Aggressive large peripheral stereopsis stimulation in video gaming mode at every session, eg. VTS-4, Vivid Vision, minimum 15-30 minutes/session

Thomas in WSF MFBF
Taylor - early stages of binocular development

A creative application

Caroline experiencing stereopsis
Treatment Phase 2
Routine general skill development
• Accommodative stimulation (mono, bi-ocular, binocular) – plus detail
• Binocular ranges of fusion
• Oculo-motor development
• Beginning levels on VIP

Phase 3-
Advanced VIP development in Amblyopic eye vs fellow eye...equate
• Advanced Visual information processing in all VIP areas monocular (using Bangerter foil, defuser on fellow eye) – plus detail recognition
• Visual Closure, Visual Spatial, Visual Figure Ground, Tachistoscopic, – plus detail recognition
• Visual motor integration – plus detail recognition

Monitoring weekly progress:
Weekly
• --Visual Acuity: Snellen (SR, SL) Distance
• --Suppression Zone: Distance and near – Worth 4 Dot Large, medium, small (VTS4)
• --Ranges of Fusion in VT activity
  – eg: Dog/Ring (VTS-4), Quoit Ring (vecto)
• -- Stereopsis: Distance and near Wirt, and near RDS

Monitor Monthly (q 8-10 visits)
• Visual Acuity – Snellen (SR, SL) Distance & Near
• CSF at near in amblyopic eye
• Dry Refraction with BVA
• Standard Binocular evaluation: von Graefe phoria, Ranges of Fusion: distance and near, Suppression check, Stereopsis: distance and near
• Accommodation: PRA, NRA, +/- 2.00 with acuity suppression (Vecto #9)
• K.D. Amblyopic eye vs both eyes
• All relevant VIP testing (Amblyopic Eye vs non-amblyopic eye)

Home: Minimum 5 hours per week
(monitor dosing carefully)
• Home Amblyopia.iNet
• Home iPad Amblyopia Tetris Blocks
• Home 3D Minecraft or something similar if available
• Home 3D movies
• PTS-2 - (Phase 3)
• Monitor home dosing of MFBF and time on video games
• Use a Diffuser (Bangerter foil) only for occlusion (monocular activities)
Goal for each patient

- To attain maximum VA, Stereopsis, Visual information processing and visual motor integration woven into their own Transfer Package.
- VA goal 20/25 or better
- Stereopsis 60” or better at far and near
- VIP abilities including reading fluency (oral reading and TOSWRF) at or above age and grade level
- KD saccades at or above age level
- VMI at or above age level.

The standard occlusion treatment model

- Acuity improves but will often regress when patching is discontinued
- **Treatment discouraged past age 10**
- Patient often experiences emotional and psycho-social trauma with standard patching
- Patient at risk of accidents while patched
- Patient maintains binocular suppression after treatment
- Patient remains “stereo-blind”

The Advanced treatment paradigm

**Age is not a barrier to treatment**

- Occlusion dosage reduced to only a few minutes a day, if at all
- Patients are not at risk of being emotionally traumatized
- Patients at no greater risk of injury
- The patient will have a more enjoyable experience in treatment, thus improved compliance
- Binocular suppression is eliminated
- The potential for stereopsis is gained

Emily’s Key Findings after treatment

- BVA OS: 20/25- (SR)
- No Suppression
- Excellent ranges of fusion
- Stereopsis: 40” Wirt

Emily’s Story

---

**OBSTACLES AHEAD**
• If Amblyopia is truly a serious disease of the visual system...
  • If the research is clear - two eyes are better than one in the treatment of amblyopia...
  • How might we facilitate change throughout optometry and ophthalmology acceptance of the advanced treatment paradigm?

• What would it look like if the standard of care for amblyopia embraced binocular vision?
• What if all patients with amblyopia could realize their true potential?
• How might we bring to the world of the amblyopic child and adult the wonder and awe of stereoscopic vision?

How might we?
• Provide Doctors with facts
  – Amblyopia Research Portal
  – Binocular Models of Treatment for Amblyopia
• Provide Patients Hope
  – Facts
  – Stories and Videos
• Provide primary eye care doctors support
  – Active collaboration VT ODs showing how the primary care ophthalmic community can implement binocular treatment as first response
Phase 1 - Advanced Amblyopia Model for Primary Care Optometrists

• Begin with judicious prescription of lenses as needed
• 2-4 week adjustment to lenses instead of 2-3 month adjustment

Phase 1 - Advanced Amblyopia Model for Primary Care Optometrists

• Return to office progress eval (92012) and Sensory motor exam(92060):
  – Establish baseline VA, distance and near
  – Measure suppression with Worth 4-Dot, distance and near
  – Measure stereo acuity

Phase 1 - Advanced Amblyopia Model for Primary Care Optometrists

• Begin Binocular treatment immediately after adaptation to Rx

Phase 1 - Advanced Amblyopia Model for Primary Care Optometrists

• Prescribe Binocular activity in computer based modality
  – Anaglyph (TV-Trainer) MFBF video gaming
    • 1 hour per day 6 days per week (and/or)

Advanced amblyopia home computer programs treatment programs in MFBF mode (and/or)

Anaglyph Binocular iPad-type games (and/or)

• 1 hour per day 6 days per week
-3D pictures and movies as much as possible

Phase 1 - Advanced Amblyopia Model for Primary Care Optometrists

- Monitor q 4 weeks x 3 months
- Past-patient exam and sensory motor exam
- Plus repeat refraction as needed
- Target >20/25, no suppression, RD Stereo acuity 20"

Phase 2 - For those with residual amblyopia

- Begin occlusion therapy [recommend graded occlusion]

OR

- Refer for Office-Based Optometric Vision Therapy
  - Intensive
  - Concentrated binocular vision development
  - Targeted
    - Visual information processing
    - Oculomotor
    - Visual-motor integration
    - Visual acuity development in a binocular field

The time has come to end "Lazy Eye"

dfortenbacher@wowvision.net

---

Resources

- The History of the Treatment of Amblyopia, S.E. Loudon, H.J. Simonsz, Strabismus, 13:93, 2005
- Amblyopia and quality of life: a systematic review, Carlton and E Kallendorf, Ophtalmology, 2011, 20, 62-71
- Amblyopia and Real-World Visualmotor Tasks, S Grant, Str Moseley, Strabismus, 8 2011; 19:43-52
- A review of research on oculomotor coordination, walking, driving, and reading skills of children and adults with amblyopia
- Personal Award Lecture 2011: Removing the Brakes on Plasticity in the Amblyopic Brain: Insights from Pedorthonomy and Research Science. VdK, MD, PhD 2011
- The psychosocial and emotional consequences of occlusion therapy….an antiquated treatment for amblyopia, Dan L. Fortenbacher, OD - The VisionHelp Blog
- Amblyopia TREATMENT STUDY - (ATS18) Study of Binocular Computer Activities for Treatment of Amblyopia
- VisionHelp Blog on Amblyopia

---

4/14/2015
Thank you!