iStrain: What effect do today's tablets and devices have on vision?

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Associate Professor, Illinois College of Optometry
Chief, Pediatrics/Binocular Vision Department, Illinois Eye Institute
Lecture Goals

- Discuss digital media use and its effect on vision
- Discuss how we diagnose these issues
- Discuss how we treat these issues
- Develop "Device Advice"
  - How do we respond to the questions our parents and patients ask
“Wait a second...how are we supposed to play on this? It’s not a video game.”
Vision Issues related to Near Point Stress
Near Point Visual Stress
Birnbaum theory

- Binocular Vision and Accommodative Disorders / Myopia onset

  - Often *stress induced* conditions
    - Motivation for academic achievement
    - Career stress

  - Results in:
    - refractive changes
    - disturbances of accommodation and convergence

  - Many disorders (CI, AI, myopia) not primary problems = adaptive changes to near point stress
    - CI and Myopia have been linked to personality and emotional factors which underlie heightened sympathetic arousal
Use Abuse Theory
Birnbaum theory

- NEI study December 2009 Archives of Ophthalmology
  - Prevalence of nearsightedness among Americans has increased from 25% to 41.6% of the population over the past 30 years
  - A 66% increase

- There is an adverse influence of the extensive near vision demands imposed by our society

- The visual system is biologically unsuited for the sustained near work demands of our culture
The Learning Habit

A Groundbreaking Approach to Homework and Parenting That Helps Our Children Succeed in School and Life

Stephanie Donaldson-Pressman • Rebecca Jackson • Dr. Robert M. Pressman
Technology has become an ever present influence on our lives. Our children have the benefit of instant communication and easy access to information. This is a wonderful thing......

Except when it isn’t
- **Spring 2011**
  - Survey > 1000 participants in 12 pediatric offices

- **Fall 2011**
  - Replicated survey to determine if the results were consistent
  - Results were nearly identical
  - Gave proof that media habits in children had a clear impact on academic success

- **Summer 2012**
  - Developed an online study of family habits that explores the effect of a child’s emotional development and social adjustment and vice versa
- This generation's use of media is **EXPONENTIAL**

- According to common Core State Standards Initiative, keyboards will soon replace pencils
"In return for an increase in my allowance, I can offer you free unlimited in-home computer tech support."
Growing Up Mobile
In the two years since Common Sense Media first reported on the media use of 0- to 8-year-olds, our latest survey in the series, Zero to Eight: Children's Media Use in America 2013, shows the media environments and behaviors of young kids have changed. More than ever, they're growing up mobile.

3/4 of all kids have access to mobile devices at home.

Smartphones are still the most common device (63%, up from 41%), but tablet ownership is 5 times higher (8% to 40%) than it was in 2011.
The number of kids who've used mobile devices has nearly doubled since 2011 (38% to 72%).

Average daily use of mobile devices has tripled, from 5 to 15 minutes a day.

**TECH SAVVY TODDLERS:**

In 2011, 10% of kids under 2 had used a mobile device. Now, that's grown to 38% of all kids under 2.

Traditional screen time is down but mobile screen time is up.

↓ 31

↑ 10
AOA surveys

- AOA American Eye-Q Survey 2014
  - **Children**
    - 85% of parents indicate their children use electronic devices up to 4 hours per day
    - 41% of children have their own smart phone or tablet
    - 32% of children are using ebooks as well as text books at school
  - **Adults**
    - 42% spend greater than 3 hours per day with computers / devices
    - 1/3 parents are concerned that hand held devices will damage their children’s vision
    - 53% believe 3D viewing may be harmful

No evidence based study has reported that new technology causes vision problems other than asthenopia
5 year old male, only child

- Question: How many hours a day does your child use media?
- Answer: 2 hours

- Reminded parent of all media devices owned reconstructed, patient day and asked more specialized questions......

5 hours and 55 minutes
Media Use guidelines

- American Academy of Pediatrics, October 2013

- The AAP recommends that parents establish "screen-free" zones at home by making sure there are no televisions, computers or video games in children's bedrooms, and by turning off the TV during dinner. Children and teens should engage with entertainment media for no more than one or two hours per day, and that should be high-quality content. It is important for kids to spend time on outdoor play, reading, hobbies, and using their imaginations in free play.
Computer Vision Syndrome
AOA definition

- Computer Vision Syndrome describes a group of eye and vision-related problems that result from prolonged computer use. Many individuals experience eye discomfort and vision problems when viewing a computer screen for extended periods. The level of discomfort appears to increase with the amount of computer use.
Computer Vision Syndrome
AOA definition

- Let us not forget.............. In addition to computer monitors
  - Smart phones
  - Tablets
  - Hand held game systems
  - HDTVs
How much do you know about computer vision syndrome (CVS)?
1) What are the symptoms of CVS?
   a) Eye strain
   b) Headaches
   c) Blurred vision
   d) Neck and shoulder pain
   e) All of the above
2) According to the AOA, what % of Americans who use computers are affected by CVS?

a) 10-15%
b) 25-30%
c) 50%
d) 70-75%
How much do you know about computer vision syndrome (CVS)?

Gary Heiting, O.D., allaboutvision.com

3) The eye responds to a printed word similarly to the way it responds to a digital image?

a) true
b) false
How much do you know about computer vision syndrome (CVS)?

Gary Heiting, O.D., allaboutvision.com

4) What is the primary reason for computer vision syndrome?

a) Glare on the computer screen
b) An inability to focus properly on the computer image
c) Images that are too small
d) Poor computer station ergonomics
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Vision and Digital Devices
Computer Vision Syndrome
AOA definition

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- The most common symptoms associated with Computer Vision Syndrome (CVS) are:
  - Eyestrain
  - Headaches
  - Blurred vision (at near and/or slow focusing at distance)
  - Dry eyes
  - Neck and shoulder pain ("text neck")
Computer Vision Syndrome Symptoms

- These symptoms may be caused by:
  - poor lighting
  - glare on the computer screen
  - improper viewing distances
  - poor seating posture
  - uncorrected vision problems
  - excessive near point tasks
  - a combination of these factors
Why do these symptoms occur?  

*In adults*

- Traditional forms of vision correction may not be appropriate for computer use
  - Patient wearing bifocals, trying to look through near area at computer
  - Patient wearing progressives with too narrow an intermediate or wrong power
Traditional Flat-Top Bifocals

Shamir Duo™ No-Line Bifocals
How we see the world

- How do our eyes (and brain) determine where something is in space?
- How far away it is?
- How does our brain determine how much the eyes need to focus?
The answer . . .

- The brain relies on basic visual clues
  - Depth perception provided by two eyes
  - Contrast between objects
  - Color change between objects
  - Well-defined edges of objects
Consider printed material

- Printed characters provide adequate visual information
- Good contrast from ink color to paper color
- Sharp transition - good edge definition
- Our vision system is programmed to understand normal printed material

is a new testing methodology used by optometrists and ophthalmologists to help computer-using patients. It results in more accurate prescription.
What happens . . .

- When our eyes don’t find good contrast or well-defined edges?
Pixels

- Present entirely different kind of image
- Image is made up of pixels, not one full image
- Pixels- picture and text drawn in little “pieces”
- Pixels are brightest in center and dimmer towards edge
- Pixels are used on computers, iPads

New LCD Screens with higher resolution will likely cause fewer CVS problems
Pixels

cor

[Images of a computer monitor and a tablet]
Computer Screen vs. Hardcopy

A comparison of symptoms after viewing text on a computer screen and hardcopy

Symptoms following sustained computer use were significantly worse than those reported after hard copy fixation under similar viewing conditions.
eInk

- Display used by eReaders (e.g. Kindle Paperwhite and Nook)
- More closely mimics the look of paper
- Less visual fatigue
The Pixel Density Race
The Pixel Density Race

- PPD = Pixels per degree
  - A way to account for both distance from the display and the resolution of the display
  - Not limited to smart phones displays
  - Applies to any type of display

- Snellen acuity chart resolution is 60 PPD

- Smallest separation at which 2 lines can be perceived as two distinct lines is 120 PPD

- Current smart phone technology PPD at 1800 PPD
Retina Display

- Retina Display is a term coined by Apple to refer to their devices that have a pixel density so high that the naked eye can’t see individual pixels. These options offer a solution to pixelation, making them much “better for your eyes.”

- Sharper text is much easier on the eye and much more pleasurable for reading.
What visual disorders do optometrists encounter most due to increased near point demands on our population?

**Binocular Vision and Accommodative Disorders**

- Convergence Insufficiency
- Accommodative Insufficiency
- Convergence Excess
- Myopia
A Visual Efficiency Testing “Handbook”
Binocular Vision Disorders
Binocular Vision Disorders

- **EXO Deviations**
  - Convergence Insufficiency
  - Basic exo deviations
  - Divergence Excess

- **ESO Deviations**
  - Convergence Excess
  - Basic eso deviations
  - Divergence Insufficiency
# DUANE’S CLASSIFICATIONS

<table>
<thead>
<tr>
<th>EXO Deviations</th>
<th>&lt;D</th>
<th>AC/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convergence Insufficiency</td>
<td>N&gt;F</td>
<td>Low</td>
</tr>
<tr>
<td>Basic EXO deviation</td>
<td>N=F</td>
<td>Normal</td>
</tr>
<tr>
<td>Divergence Excess</td>
<td>F&gt;N</td>
<td>High</td>
</tr>
</tbody>
</table>

N = near fixation distance / F = far fixation distance
**DUANE’S CLASSIFICATIONS**

**ESO Deviations**  
N = near fixation distance / F = far fixation distance

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</table>
Clinical Vergence Disorders
Soft Binocular Vision Problems
Scheiman/Wick

**Phoria Norms**
Cover test and phoropter measurements

<table>
<thead>
<tr>
<th>Distance</th>
<th>ortho - 2 $\Delta$ exophoria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Near</td>
<td>ortho - 6 $\Delta$ exophoria</td>
</tr>
</tbody>
</table>
How to record Smooth Vergence Measurements

Blur / break / recovery

- **Blur** - patient reports blur
- **Break** - patient reports diplopia
- **Recovery** - patient reports fusion (diplopia is eliminated)
How to record Smooth Vergence Measurements

**Blur / break / recovery**

- **Blur**
  - Fusional vergence is used up
  - Accommodation adjusting to maintain fusion
    - Measures amount of fusional vergence free of accommodation
    - Should not be noted when testing distance vergences

- **Break**
  - Patient uses up all vergence sources
    - Measures total amount of fusional and accommodative vergence

- **Recovery**
  - Point where patient can re-access vergence system to regain single vision/fusion
    - Image may still be blurry
## Clinical Vergence Disorders
### Soft Binocular Vision Problems
*Scheiman/Wick*

<table>
<thead>
<tr>
<th>Vergences</th>
<th>Base In</th>
<th>Base Out</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Near</strong></td>
<td>11/19/10</td>
<td>14/18/7</td>
</tr>
<tr>
<td><strong>Distance</strong></td>
<td>x/6/3</td>
<td>7/15/8</td>
</tr>
</tbody>
</table>
### Clinical Vergence Disorders

**Soft Binocular Vision Problems**

*Scheiman/Wick*

<table>
<thead>
<tr>
<th>Vergences</th>
<th>Near</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base In</td>
<td>x/13/10</td>
<td>x/7/4</td>
</tr>
<tr>
<td>Base Out</td>
<td>x/19/14</td>
<td>x/11/7</td>
</tr>
</tbody>
</table>

*Prism Bar Vergences/Step Vergence ADULTS*
### Clinical Vergence Disorders

**Soft Binocular Vision Problems**

Scheiman/Wick

<table>
<thead>
<tr>
<th>Vergences</th>
<th>Prism Bar Vergences/Step Vergence</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CHILDREN</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Near</strong></td>
<td></td>
</tr>
<tr>
<td>Base In</td>
<td>x/12/7</td>
</tr>
<tr>
<td>Base Out</td>
<td>x/23/16</td>
</tr>
<tr>
<td><strong>Distance</strong></td>
<td></td>
</tr>
<tr>
<td>Base In</td>
<td>None established</td>
</tr>
<tr>
<td>Base Out</td>
<td>None established</td>
</tr>
</tbody>
</table>
### Near Point of Convergence Testing

#### NPC
Near Point of Convergence

<table>
<thead>
<tr>
<th></th>
<th>Break</th>
<th>6 cm</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Children</strong></td>
<td>Break</td>
<td>6 cm</td>
</tr>
<tr>
<td>Adults</td>
<td>Accommodative target</td>
<td>5cm/8cm (break/recovery)</td>
</tr>
<tr>
<td></td>
<td>Red lens / transilluminator</td>
<td>7cm/10cm (break/recovery)</td>
</tr>
</tbody>
</table>
Worth 4 -dot - Sensory Fusion
Worth 4 dot

- 4 dots = **stable fusion** with no suppression

- Diplopia (5 dots) - Unstable Fusion
  - *decreased sensory-fusion*
    - cannot integrate 2 images
  - *insufficient motor fusional vergence*
    - add prism to ↓ vergence demand
<table>
<thead>
<tr>
<th>Test Distance</th>
<th>Subtends</th>
</tr>
</thead>
<tbody>
<tr>
<td>16”</td>
<td>4.5°</td>
</tr>
<tr>
<td>36”</td>
<td>2°</td>
</tr>
<tr>
<td>6’</td>
<td>1°</td>
</tr>
<tr>
<td>10’</td>
<td>0.6°</td>
</tr>
<tr>
<td>20’</td>
<td>0.3°</td>
</tr>
</tbody>
</table>
Accommodative Disorders
Accommodative Disorders

- **Accommodative Insufficiency**
  - Insufficient amplitude of accommodation to afford clear imagery of a stimulus object at a specified distance, usually the normal or desired reading distance.

- **Accommodative Excess**
  - Accommodation in excess of the amount required for sharpest imagery of the stimulus object.

- **Accommodative Infacility** (inertia of accommodation)
  - Slow or difficult accommodative response to dioptric change in stimulus; especially sluggish accommodative response to changes in fixation distance.
### Accommodative Testing

<table>
<thead>
<tr>
<th>Test</th>
<th>Normative Value</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Push up/Pull away amplitudes</td>
<td>15- ¼ age</td>
<td>+/- 2.00D</td>
</tr>
<tr>
<td>NRA</td>
<td>+2.00 D</td>
<td>+/- 0.50 D</td>
</tr>
<tr>
<td>PRA</td>
<td>-2.37D</td>
<td>+/- 1.00 D</td>
</tr>
<tr>
<td>Minus lens amplitudes</td>
<td>15- ¼ age – 2D</td>
<td></td>
</tr>
<tr>
<td>MEM (monocular estimation method)</td>
<td>+0.50 D</td>
<td>+/- 0.25 D</td>
</tr>
<tr>
<td>Fused X-cylinder</td>
<td>+0.50 D</td>
<td>+/- 0.25 D</td>
</tr>
</tbody>
</table>

- **Note:** for amplitudes always be aware of even a small difference between the 2 eyes that is repeatable
  - If this is backed up by symptoms there may be an accommodative problem
Blur reported at 8 cm = What is amplitude?
100/8 = 12.5 D OD
Pull Away OD
Pull Away OD
Pull Away OD

- Read 20/20 letter at 9 cm = What is amplitude?
- 100/9 = 11 D OS
# Accommodative Facility

## Accommodative Facility Testing

<table>
<thead>
<tr>
<th>Test type</th>
<th>Population</th>
<th>Normative Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Binocular</strong></td>
<td>Children (7-12)</td>
<td>5.0 cpm</td>
</tr>
<tr>
<td></td>
<td>Adults</td>
<td>8.0 cpm</td>
</tr>
<tr>
<td><strong>Monocular</strong></td>
<td>Children 7-12</td>
<td>7.0 cpm</td>
</tr>
<tr>
<td></td>
<td>Adults</td>
<td>11-12 cpm</td>
</tr>
</tbody>
</table>
Binocular Vision Disorder Summaries
# Convergence Insufficiency

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intermittent blur</td>
<td>Moderate to high exophoria or intermittent exotropia at near</td>
</tr>
<tr>
<td>Intermittent diplopia</td>
<td>Reduced positive fusional vergence at near</td>
</tr>
<tr>
<td>Symptoms worse at end of day</td>
<td>Low AC/A ratio</td>
</tr>
<tr>
<td>Burning and tearing</td>
<td>Low NRA</td>
</tr>
<tr>
<td>Inability to sustain and concentrate</td>
<td>Low MEM</td>
</tr>
<tr>
<td>Words move on the page</td>
<td>Fails binocular accommodative facility testing with +2.00</td>
</tr>
<tr>
<td>Sleepiness when reading</td>
<td>Intermittent suppression at near</td>
</tr>
<tr>
<td>Decreased reading comprehension over time</td>
<td>Receded near point of convergence</td>
</tr>
<tr>
<td>Slow reading</td>
<td>Normal accommodative amplitudes</td>
</tr>
</tbody>
</table>
## Fusional Vergence Dysfunction

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asthenopia and headaches</td>
<td>Orthophoria or a low degree of eso or exophoria at distance and near</td>
</tr>
<tr>
<td>Intermittent blur</td>
<td>Reduced positive fusional vergence</td>
</tr>
<tr>
<td>Symptoms worse at end of day</td>
<td>Normal AC/A</td>
</tr>
<tr>
<td>Burning and tearing</td>
<td>Low NRA and PRA</td>
</tr>
<tr>
<td>Inability to sustain and concentrate</td>
<td>Fails binocular accommodative facility testing with both plus and minus</td>
</tr>
<tr>
<td>Sleepiness when reading</td>
<td>Normal monocular accommodative facility</td>
</tr>
<tr>
<td>Decreased reading comprehension over time</td>
<td></td>
</tr>
<tr>
<td>Slow reading</td>
<td></td>
</tr>
</tbody>
</table>
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<td>Asthenopia and headaches</td>
<td>Significant esophoria at near</td>
</tr>
<tr>
<td>Intermittent blur</td>
<td>Reduced negative fusional vergence at near</td>
</tr>
<tr>
<td>Intermittent diplopia</td>
<td>High AC/A ratio</td>
</tr>
<tr>
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<td>Low PRA</td>
</tr>
<tr>
<td>Burning and tearing</td>
<td>High MEM</td>
</tr>
<tr>
<td>Inability to sustain and concentrate</td>
<td>Fails binocular accommodative facility testing with -2.00</td>
</tr>
<tr>
<td>Sleepiness when reading</td>
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Accommodative Disorder Summaries
## Accommodative Insufficiency

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<th>Signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blurred vision at near</td>
<td>Low accommodative amplitudes</td>
</tr>
<tr>
<td>Discomfort and strain associated with near tasks</td>
<td>Low PRA</td>
</tr>
<tr>
<td>Fatigue associated with nearpoint tasks</td>
<td>High MEM</td>
</tr>
<tr>
<td>Symptoms worse at end of day</td>
<td>Fails monocular accommodative facility with minus lenses</td>
</tr>
<tr>
<td>Difficulty with attention and concentration with reading</td>
<td>BAR - Fails (-)</td>
</tr>
</tbody>
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## Accommodative Excess

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<td>Low NRA</td>
</tr>
<tr>
<td>Fatigue associated with nearpoint tasks</td>
<td>Low MEM, BAR - Fails (+)</td>
</tr>
<tr>
<td>Intermittent blurred distance vision, worse after reading</td>
<td>Fails monocular accommodative facility with plus</td>
</tr>
<tr>
<td>Difficulty with attention and concentration with reading</td>
<td>Variable acuity findings</td>
</tr>
<tr>
<td></td>
<td>Variable retinoscopy and subjective findings</td>
</tr>
<tr>
<td></td>
<td>Low degree of A/R astigmatism</td>
</tr>
</tbody>
</table>
## Accommodative Infacility

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<td>Normal accommodative amplitudes</td>
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<tr>
<td>Fatigue associated with nearpoint tasks</td>
<td>Low NRA/PRA</td>
</tr>
<tr>
<td>Blurred vision when changing fixation form one distance to another</td>
<td>Low MEM</td>
</tr>
<tr>
<td>Difficulty with attention and concentration with reading</td>
<td>Fails monocular accommodative facility with plus and minus</td>
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What visual disorders do optometrists encounter most due to increased near point demands on our population?

**Binocular Vision and Accommodative Disorders**

**Convergence Insufficiency**
Convergence Insufficiency

What are they going to say?
## Convergence Insufficiency

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Convergence Insufficiency

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Convergence Insufficiency

What are you going to do?
Convergence Insufficiency Treatment Options

- **Lenses**
  - Refractive Error as necessary
  - Optimize spectacle and/or contact lens Rx

- **Added Lenses**
  - Prism

- **Orthoptics / Vision Therapy**
  - generally requires 12-24 office visits
  - dependent upon age, motivation, compliance
Vision therapy / orthoptics was the only treatment that produced clinically significant improvements in the near point of convergence and positive fusional vergence. Half the patients (58%) were still symptomatic at the end of treatment, although their symptoms were significantly reduced. All three groups demonstrated statistically significant changes in symptoms with 42% in office based vision therapy/orthoptics, 31% in office based placebo vision therapy/orthoptics, and 20% in home based pencil push ups.

A randomized clinical trial of vision therapy/orthoptics versus pencil push-ups for the treatment of convergence insufficiency in young adults

Convergence Insufficiency Studies

Base in prism reading glasses were found to be no more effective in alleviating symptoms, improving the near point of convergence, or improving positive fusional vergence at near than placebo reading glasses for treatment of children aged 9 to < 18.

Randomized clinical trial of the effectiveness of base in prism reading glasses versus placebo reading glasses for symptomatic convergence insufficiency in children

12 weeks of office based vergence and accommodative therapy results in a significantly greater improvement in symptoms and clinical measures of near point of convergence and positive fusional vergence and a greater percentage of patients reaching the predetermined criteria of success compared with home based pencil push ups, home based vergence and accommodative therapy, and office based placebo treatment.

Randomized clinical trial of treatments for symptomatic convergence insufficiency in children
Arch Ophthalmol. 2008 Oct;126 (10):1336-49 (CITT group)
Case: 10 year old Hispanic Female

- **Chief Complaint:**
  - Frontal HA daily w/ new Rx
  - Either eye turns out: left more often
  - Intermittent diplopia and blur at near *(words move on page)*
  - Symptoms worse at end of day
  - Normal ocular and systemic health

- **Current Rx:**
  - OD    -1.75 sph
  - OS    -1.50 sph
Case: 10 year old Hispanic Female
## Initial Findings

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<thead>
<tr>
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<th>Distance</th>
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</tr>
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<tr>
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<td>20/20 OD, OS</td>
<td>20/20 OD, OS</td>
</tr>
<tr>
<td><strong>Retinoscopy = Subjective</strong></td>
<td>-1.75 sph</td>
<td>20/20</td>
</tr>
<tr>
<td></td>
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<td>20/20</td>
</tr>
<tr>
<td><strong>Cover Test cc</strong></td>
<td>18Δ IAXT</td>
<td>40Δ IAXT</td>
</tr>
<tr>
<td></td>
<td>(very high frequency)</td>
<td></td>
</tr>
<tr>
<td><strong>Near Prism Bar Vergences cc</strong></td>
<td><strong>Base In</strong></td>
<td><strong>Base Out</strong></td>
</tr>
<tr>
<td></td>
<td>x/14/8</td>
<td>x/1/no recovery</td>
</tr>
<tr>
<td></td>
<td>x/12/7</td>
<td>x/23/16</td>
</tr>
<tr>
<td><strong>NPC</strong></td>
<td>20cm/no recovery</td>
<td>5cm/8cm</td>
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### Initial Findings

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<tr>
<td>Worth 4 Dot</td>
<td>fused</td>
<td>Diplopia Fused with 8ΔBI</td>
</tr>
<tr>
<td>Minus lens Amps</td>
<td>5.50 OD, 5.25 OS</td>
<td>norm = 9-10 D</td>
</tr>
<tr>
<td>Stereopsis</td>
<td>(-) RDS, (-) Fly (+) fusion with prism</td>
<td></td>
</tr>
</tbody>
</table>
Worth 4 -dot - Sensory Fusion
Worth 4 dot

- 4 dots = *stable fusion* with no suppression

- Diplopia (5 dots) - Unstable Fusion
  - *decreased sensory-fusion*
    - cannot integrate 2 images
  - *insufficient motor fusional vergence*
    - add prism to \( \downarrow \) vergence demand
Addition of $8\Delta BI$ near
## What did we see?

### Convergence Insufficiency

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Assessment / Plan

- Assessment
  - Myopia OU
  - Convergence insufficiency

- Plan
  - Rx given: -1.50 sph OU
  - +1.75 add OU due to very low amps., HA, and discomfort w/ minus Rx
  - 4Δ BI OD, OS to aid fusion (8Δ BI total)
  - Referred for Vision therapy / orthoptic training
Orthoptic Treatment Results

- Obtained prism Rx after 6 weeks of VT - some relief immediately
- Gradually improved fusion/reduced diplopia in the next 6 weeks of VT
- Now reports NO diplopia except when tired (can recover fusion)
- Cover Test shows exophoria at all distances
- NPC to nose
- Minus lens amps: 10 D OD/OS
Intermittent Strabismus

**Treatment Tips**

- **Prism Rx**
  - Ideal for patients who demonstrate an exo deviation at near as well as distance
  - Can be used in conjunction with orthoptic program to ease convergence demand
  - Ideal for patients unable to commit to an orthoptic program

- **Orthoptic Training**
  - Treatment option for convergence insufficiency patients
  - Lack of success typically coincident with lack of compliance therefore not an ideal option if patient not committed and/or motivated for orthoptic treatment
Treatment of Strabismus with Relieving Prism

- **Proper patient selection**
  - **Proper diagnostic criteria**
    - Normal sensory skills
      - Must eliminate sensory problems before Rxing relieving prisms
    - Motor skills are high
      - May need orthoptics or surgery to improve motor skills before Rxing relieving prism
  - (+) Fusion ability
    - evaluate sensory fusion
    - evaluate motor fusion

- Intermittent deviations or deviations with the capability of motor fusion skills
To Summarize:

Patients MUST have the ability to FUSE in order to successfully use prism as a treatment option.
Prism Rx given with weekly active orthoptic therapy

↓

Orthoptic therapy increases convergence (BO) amplitudes

↓

The goal is to decrease in the amount of prism reliance over time

↓

A decreased magnitude of prism correction helps to increase fusional effort & slow vergence adaptation
Relieving Prism

- *Reduces, does not eliminate motor fusion demand*

- Rx the minimal amount of prism that will achieve comfortable binocular vision
  - Too small a prism Rx will not allow BV to be attained or maintained

- Current Rx of 45 y.o. patient with a 30Δ IXT Convergence Insufficiency diagnoses:
  - +1.75 -0.75 x 080 1Δ BI
  - +1.75 -0.75 x 085 1Δ BI
  - +2.50 Add

- Rx enough prism to stabilize Sensorimotor Fusion
  - Decrease over time as motor fusion increases or size of deviation ↓
Relieving Prism

- **Expected Residual deviations**
  - Esotropia = 4 - 6 Δ
  - Exotropia = 10 - 15 Δ
  - Vertical deviations = 2 - 4 Δ
What visual disorders do optometrists encounter most due to increased near point demands on our population?

Binocular Vision and Accommodative Disorders

Convergence Excess
Convergence Excess

What are they going to say?
## Convergence Excess

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Convergence Excess

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Convergence Excess

What are you going to do?
Convergence Excess Treatment Options

- **Lenses**
  - Refractive Error as necessary
  - Optimize spectacle and/or contact lens Rx

- **Added Lenses**
  - **Plus lenses**
    - Lowest amount of plus to eliminate symptoms and normalize exam data
  - **Prism**
    - Rarely needed 2° high AC/A ratio

- **Orthoptics / Vision Therapy**
  - Generally requires 12-24 office visits
  - Dependent upon age, motivation, compliance
Vision Therapy for Convergence Excess

Record review of 83 patients with CE

Vision therapy was successful in enhancing negative fusional vergence and eliminating symptoms in the vast majority of patients with convergence excess and should be considered an effective treatment for this condition.

84% of patients reported a total elimination of initial symptoms.
Case Report
10 year old female

- **Case History**
  - c/o distance blur without Rx OD, OS
  - Lost Rx several months ago
  - 1st Rx at 7 years old
  - c/o difficulty with near work when wearing Rx
  - (+) Asthenopia and headaches cc
    - Worsens at end of day
    - Extreme fatigue with near work
    - Not present without Rx

- **Medical History**
  - Heart defect
    - entering hospital next day for surgical procedure with extended stay
  - NKMA
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<td>ortho</td>
<td>18∆ IAET</td>
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<td>Base Out x/25/20</td>
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AC/A ratio

AC/A ratio = 12 X' ↔ 18 E' = 30 / 4 = 7.5 / 1
10 year old female

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<td><strong>Minus Lens Amplitude</strong></td>
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<td>5.0D</td>
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<td><em>(age expected = 10.5D)</em></td>
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<td><em>(difficulty with minus)</em></td>
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<tr>
<td><strong>MEM</strong></td>
<td>+0.50 D</td>
<td><em>all meridians</em></td>
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*(difficulty with minus)*
10 year old Female

Assessment
- Myopia OU
- Convergence Excess
- Accommodative Insufficiency

Plan
- Rx given
  - OD: -4.00 -0.75 x 090
  - OS: -4.50 sphere +2.00 Add
With +2.00 D Add

AC/A ratio = 12 X' ↔ 18 E' = 30 /4 = 7.5/1
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Convergence Excess Treatment Options

- **Lenses**
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- **Added Lenses**
  - **Plus lenses**
    - Lowest amount of plus to eliminate symptoms and normalize exam data
  - **Prism**
    - Rarely needed 2° high AC/A ratio

- **Orthoptics / Vision Therapy**
Accommodative Insufficiency

What are they going to say?
## Accommodative Insufficiency

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<td>Discomfort and strain associated with near tasks</td>
<td>Low PRA</td>
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<tr>
<td>Fatigue associated with nearpoint tasks</td>
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<td>Fails monocular accommodative facility with minus lenses</td>
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<td>Difficulty with attention and concentration with reading</td>
<td>BAR - Fails (-)</td>
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Accommodative Insufficiency

What are you going to see?
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Accommodative Insufficiency

- Clinical findings
  - “mushy” VA
    - Often at distance as well as near
  - Low A/R cylinder noted on retinoscopy
Low A/R Cylinder – Birnbaum Theory

Onset of myopia often preceded by low A/R cyl (Hirsch 1964)

\[ \downarrow \]

A/R cyl is an early adaptation

Lag of accommodation is present during near work

(Accommodation is localized beyond the plane of regard)

\[ \downarrow \]

A/R cyl produces vertically oriented blur circles which permit resolution of the vertically oriented characters of our language

\[ \downarrow \]

A/R cyl permits one to accommodate less while maintaining adequate visual resolution at neat point with a minimum loss of distance visual acuity
Low A/R Cylinder – Birnbaum Theory

As Near point stress persists or visual efficiency is unsatisfactory

↓

Myopia development may occur

We often see low A/R cyl reduce or disappear with plus lens treatment or vision therapy
Accommodative Insufficiency

What are you going to do?
Accommodative Insufficiency
Treatment Options

- **Added Lenses**
  - Refractive error as necessary
  - Optimize spectacle and/or contact lens Rx

- **Plus lenses**
  - need reflected in clinical signs

- **Orthoptics / Vision Therapy**
  - generally requires 12-24 office visits
    - dependent upon age, motivation, compliance
Accommodative Insufficiency Treatment

Treatment of Accommodative Dysfunction in Children: results from a Randomized Clinical Trial
Optometry and Vision Science, Vol. 88, No.11, November 2011, Scheiman, M., Cotter S, et.al.

- 211 children ages 9-17 with symptomatic CI
  - 74% had accommodative dysfunction
  - 29% had decreased amplitude of accommodation when compared to age norms
  - 19% had decreased accommodative facility
  - 26% both

Conclusion:
Vision therapy/orthoptics was effective for improving decreased accommodative amplitude and accommodative facility
Case Report
16 year old female

- **Case History**
  - c/o distance blur and headaches at end of day, (+) Asthenopia
  - Intermittent near blur, print comes in and out
  - (-) diplopia
  - **Medical hx** -
    - Premature 24 weeks, 2 lbs 1 oz
    - Developmental delay (mild)
    - NKMA
16 year old female

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<td><strong>Trial Frame +1.00 D</strong></td>
<td></td>
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<tr>
<td><strong>OU</strong></td>
<td>Near VA = 20/20</td>
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<td></td>
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<td>12/13/6</td>
<td>18/38/28</td>
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### 16 year old female

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16 year old female

**Assessment**
- Accommodative Insufficiency
- Myopia OU / A/R astigmatism OD

**Plan**
- Plus lenses for extended periods of near work
  - No minus Rxed at 1st visit
- Orthoptic Training program initiated
  - 8 weeks → completion
  - At completion
    - Amps = 11 D OU (approximately 4.50 D to start)
    - Able to clear minus
- Continue with plus lenses for extended periods of near work
  - At completion of orthoptic training distance VA = 20/20 uncorrected
## Accommodative Insufficiency

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</thead>
<tbody>
<tr>
<td>Blurred vision at near</td>
<td>Low accommodative amplitudes</td>
</tr>
<tr>
<td>Discomfort and strain associated with near tasks</td>
<td>Low PRA</td>
</tr>
<tr>
<td>Fatigue associated with nearpoint tasks</td>
<td>High MEM</td>
</tr>
<tr>
<td>Symptoms worse at end of day</td>
<td>Fails monocular accommodative facility with minus lenses</td>
</tr>
<tr>
<td>Difficulty with attention and concentration with reading</td>
<td>BAR - Fails (-)</td>
</tr>
</tbody>
</table>
Accommodative Insufficiency
Treatment Options

- Added Lenses
  - uncorrected refractive error
- Plus lenses
  - need reflected in clinical signs
- Orthoptics / Vision Therapy
  - generally requires 12-24 office visits
    - dependent upon age, motivation, compliance
Case Report
8 year old female

- **Case History**
  - c/o near blur (minimal distance blur)
  - (+) headaches and (+) asthenopia at end of day
  - Gets tired easily when reading
  - Intermittent near blur, print comes in and out
  - (-) diplopia
  - Sleeps or stops reading to relive symptoms
- **Medical hx -**
  - unremarkable
  - NKMA
### Initial Findings

<table>
<thead>
<tr>
<th></th>
<th>Distance</th>
<th>Near</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Visual Acuity</strong></td>
<td>20/20 OD, 20/20 OS</td>
<td>20/25 OD, 20/30 OS</td>
</tr>
<tr>
<td></td>
<td>Variable responses</td>
<td></td>
</tr>
<tr>
<td><strong>Cover Test</strong></td>
<td>3 Δ X’</td>
<td>6 Δ X’</td>
</tr>
<tr>
<td><strong>Retinoscopy</strong></td>
<td>+0.50 -0.50 x 090</td>
<td>20/25</td>
</tr>
<tr>
<td></td>
<td>+0.50 -0.50 x 090</td>
<td>20/20</td>
</tr>
<tr>
<td><strong>Near Prism Bar</strong></td>
<td><em>Base In</em>  x/10/8 x/12/7</td>
<td></td>
</tr>
<tr>
<td><strong>Vergences</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Base Out</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>x/14/6 x/23/16</td>
<td></td>
</tr>
</tbody>
</table>
# 8 year old female

<table>
<thead>
<tr>
<th>Accommodative Testing</th>
<th>OD</th>
<th>OS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minus Lens Amplitude</td>
<td>9.50D</td>
<td>9.75D</td>
</tr>
<tr>
<td><em>(age expected = 10.0D)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NRA/PRA</td>
<td>+1.25/-2.50</td>
<td></td>
</tr>
<tr>
<td>Binocular Accommodative Facility</td>
<td>Unable to clear plus lenses</td>
<td></td>
</tr>
<tr>
<td>Monocular Accommodative Facility</td>
<td>Unable to clear plus lenses</td>
<td></td>
</tr>
<tr>
<td>MEM</td>
<td>+0.50 D <em>all meridians</em></td>
<td></td>
</tr>
</tbody>
</table>
8 year old Female

- **Assessment**
  - Accommodative Excess

- **Plan**
  - Treatment Options
Accommodative Excess Treatment Options

- **Added Lenses**
  - uncorrected refractive error
  - Plus lenses not helpful
    - reflected in clinical signs

- **Orthoptics / Vision Therapy**
  - generally requires 12-24 office visits
    - dependent upon age, motivation, compliance
# Accommodative Excess

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blurred vision at near</td>
<td>Normal accommodative amplitudes</td>
</tr>
<tr>
<td>Discomfort and strain associated with near tasks</td>
<td>Low NRA</td>
</tr>
<tr>
<td>Fatigue associated with nearpoint tasks</td>
<td>Low MEM</td>
</tr>
<tr>
<td></td>
<td>BAR - Fails (+)</td>
</tr>
<tr>
<td>Intermittent blurred distance vision, worse after reading</td>
<td>Fails monocular accommodative facility with plus</td>
</tr>
<tr>
<td>Difficulty with attention and concentration with reading</td>
<td>Variable acuity findings</td>
</tr>
<tr>
<td></td>
<td>Variable retinoscopy and subjective findings</td>
</tr>
<tr>
<td></td>
<td>Low degree of A/R astigmatism</td>
</tr>
</tbody>
</table>
8 year old  Female

- **Assessment**
  - Accommodative Excess

- **Plan**
  - No Rx
  - Orthoptic treatment initiated
  - Completed in 12 weeks
  - Symptoms relieved
Devise Advice

Visual
20-20-20 Rule
Visual Rules to help prevent eyestrain for children (and adults)

- 20-20-20 Rule

- Choose a comfortable supportive chair so that the child’s feet are on the ground
- Suggest that they limit leisure screen time to 2 hours/day (this includes TV watching, playing video games, and using mobile devices)
- Take notice if children are squinting, rubbing eyes
- Remind children to blink more regularly
- Check for glare and reflections on the screen
- Adjust lighting
- Remember that kids do not have awareness of the time they spend on many media devices
Visual Rules to help prevent eyestrain for children (and adults)

- **Pre-school and Kindergarten aged children**
  - Limit tech time to 2 hours or less daily
  - Increase font size

- **Elementary school children**
  - Cell phones for quick tasks only
  - Hold device at Harmon’s distance slightly below eye level
  - Take frequent breaks

- **Middle school and high school students**
  - Place the screen 20-28 inches from your child’s eyes. Align the top of the screen at eye level
  - Use small devices (phones) for quick tasks (texting) do not use to read articles and documents
  - Build in breaks every hour
7 things you’re doing at your desk that will give you eye strain

Don’t wear glasses with an old prescription. For maximum comfort, ask your eye doctor about custom computer eyeglasses.

Old monitors and low-resolution screens are hard on the eyes. Upgrade to a high-resolution flat panel display for less eye fatigue.

Eye strain can be caused by excessive lighting. Overhead lighting should be no brighter than your screen.

Avoid “turtleing” – sitting with your back rounded, chin jutting forward and head tilted back – to get closer to your screen. If you can’t see your screen clearly with good posture, visit an eye doctor.

Sitting too close to the screen can cause eye fatigue and blurred vision.

Having your mouse too far away will make you lean closer to your screen, increasing focusing strain.

Are you sitting in a bad chair? Your back should be supported so you can sit upright and at a comfortable viewing distance from your screen.
Other Quick Tips:

**Get an eye exam:**
Your eye doctor can identify vision problems and prescribe special computer glasses for greater viewing comfort.

**Avoid "computer stare":**
It’s easy to forget to blink when looking at a computer screen. Remember to blink often and fully to keep your eyes moist and comfortable.

**The “20x4” (20-20-20-20) rule:**
Keep your eyes at least 20 inches from your screen and take a 20-second break every 20 minutes to look at something at least 20 feet away.
Optometric Practitioner Tips

- Determine optimal refractive errors
  - Smaller refractive errors may have more of an impact on patients with digital eyestrain
  - Monitor uncorrected hyperopia
  - Monitor uncorrected astigmatism

The effects of induced oblique astigmatism on symptoms and reading performance while viewing a computer screen


The presence of induced astigmatism produced a significant increase in post task symptoms...the correction of small astigmatic refractive errors may be important in optimizing patient comfort during computer operation
Optometric Practitioner Tips

- Rule out accommodative and binocular vision disorders

- Consider lens options that best suit patients need
  - “prism isn't poison”
  - Bifocal
  - PAL
  - Consider need for multiple spectacle Rxs

- Educate parents on ALL treatment options
Devise Advice
Parent Education
The Three C’s of media use:

- **Consumption** - to take in or use media passively without contributing
- **Creation** - To produce and distribute something in a way that requires active engagement, acquired skills, and complex problem solving
- **Communication** - to use media to connect with another person

“After reading these sections no parent will be able to say they don’t have reason to limit their child’s media consumption and communication between 1-2 hours per day”
Advice to Parents who complain to their optometrist and ask about limiting media consumption and communication

- Common Sense
- Flexibility
- Awareness
- Develop a plan/rules
  - Communicate these rules to your children
  - Enforce your rules
- Develop some alternatives to media use
Advice to Parents who complain to their optometrist and ask about limiting media consumption and communication

- **Media Tracking**
  - Media consumption extends far beyond TV
  - Cell phones and tablets allow children to play games and watch videos ANYWHERE

  “Start by making a list of your media devices and your children’s. Track your children’s media use by device. You will be surprised how quickly it adds up”
Media Creation

- Play through technology is the way children learn to use technology.

“The goal for parents is to use media CREATION to both inspire and prepare children for 21st-century skills.”

- All combined research revealed that children are able to naturally regulate themselves when it come to media creation.
<table>
<thead>
<tr>
<th>Media Creation</th>
<th>Media Communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blogging</td>
<td>Texting</td>
</tr>
<tr>
<td>Power point presentation</td>
<td>Surfing the web</td>
</tr>
<tr>
<td>Making videos</td>
<td>Social media</td>
</tr>
<tr>
<td>Creating animation</td>
<td></td>
</tr>
<tr>
<td>Learning touch typing</td>
<td></td>
</tr>
</tbody>
</table>
Family challenges

“Swap Out”
- Swap out 30 minutes of media consumption or communication for a non-media activity (sports, board games, face to face conversation etc.)

Cell phone STOP station
- Leave phones in this area
- Determine times that they can be used

Media Time Out
- Pick a block of extended time with no media use

Reading Challenge
- Determine a 24 hour age appropriate reading goal for every member of the family
The Omnipresent Power of the Cell Phone

I can't think of another single device that changed the family dynamics of our home, and the relationship I’ve enjoyed with my son, as much as the smartphone. Our cell phone rules and experiences have been fluid. They started with the basics: passwords (we have always required them), parental controls (installed on his phone), and time limits. They have changed over the years, as we—as a family—have changed.

I'm much more careful about my own cell phone use since my son got his. I try harder to be fully present when I'm with him, because that's the behavior I want to encourage. I leave my phone at home, just to show that I can, and I feel better when I do. (Sometimes, I just take the pictures in my mind.)

Here are a few things I've learned along the way:

✓ I made my child wait until he was 14 to get a smartphone. I wish I had waited longer.

✓ That phone will become the most important thing in your child's life. Be prepared for it.

✓ Your child will walk around staring at their phone. They will seem distracted and irritated when they can't look at it.

✓ Your child now has another way of communicating with their friends, people they like, people they don't like, and you. Be prepared for a breakdown in verbal communication with you.

✓ When given a choice, they will send you a text rather than call. Have rules about calling—it's important that they don't forget how!

✓ “Quality time” with your child will never be the same. If they own a phone, they are multitasking. It's a new and strange feeling to constantly share your child, even when they are with you.

✓ The way they experience the world will forever be changed. The first time you catch them staring into their phone at a concert while videotaping it, you'll understand. Stress the importance of being fully present at their lives.

✓ As hard as you try, you can't place digital limits on communication—Snapchat and Twitter messages are just a few sites that allow children to get around parental texting limits. You'll have to monitor this, and it will make you feel uncomfortable to do that. You'll get over it and so will your kids, but your relationship with them will never be quite the same.

✓ You can control how your child uses their phone—in your presence—with clear rules. Don't give up that power.

✓ You can control where and when your child can use their cell phone in your house, by establishing clear rules. Don't give up that power.

✓ Your child will wake up exhausted if you let them take a cell phone into their room at night... so don't.

✓ Your child's grades will start to decrease if they don't turn the cell phone off during homework time.

✓ Explain to your child that digital footprints last forever.* Talk to them about respecting their body and those of other people. Have a clear plan about what will happen if your child uses the phone for sexting, bullying, taking or receiving naked pictures, and posting destructive content online. Make sure they know the plan, make sure you follow through the second it happens... for sure: Something, at some point, will happen.

* Except when they don't—Wickr and other apps claim that they delete messages after a specified length of time.
Lecture Goals

- Discuss digital media use and its effect on vision
- Discuss how we diagnose these issues
- Discuss how we treat these issues
- Develop “Device Advice”
  - How do we respond to the questions our parents and patients ask
Questions??

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