Objectives

• To consider how individuals use electronic displays today.
• To appreciate the difference between electronic and printed materials.
• To discuss how the clinical examination needs to be modified to meet modern visual requirements.

Use of computers at work

• Approximately 75% of all jobs in the United States now rely on computers (Kanitar et al., 2005)

Use of computers outside work

• Use of computers for home and “leisure” activities is now almost universal [e.g., internet, e-mail, online shopping, games, social interaction (e.g., Facebook, Twitter, etc)].
Internet Use

• A recent estimate of internet usage by continent ranged from 77.4% of the population of North America to 10.9% of Africa, with an estimated 1,966,514,816 users worldwide (or 28.7% of the world’s population).

• A recent investigation of over 2000 American children between 8 and 18 years of age reported that in an average day they spend approximately 7.5 hours using entertainment media, comprising 4.5 hours watching TV, 1.5 hours on a computer and over an hour playing video games.
Smartphones

- 67% of adults between 18 and 24 years of age own a smartphone.
- Young adults send an average of 109 text messages a day and check their phones 60 times in a typical day.
Font size while using a smart phone and either reading a text message or viewing a webpage on the internet.

- **Text message**
  - Range of text sizes = 0.7M to 2.1M (mean = 1.1M)
  - Range of text sizes = 20/27.6 to 20/117.7 (mean = 20/64)

- **Webpage**
  - Range of text sizes = 0.3M to 1.4M (mean = 0.8M)
  - Range of text sizes = 20/19.7 to 20/95 (mean = 20/50.3)
  
(Bababekova et al. OVS 2011; 88: 795-7)

Working distances while using a smart phone and either reading a text message or viewing a webpage on the internet.

- **Text message**
  - Range of working distances = 17.5 to 58.0cm (mean = 36.2cm)

- **Webpage**
  - Range of working distances = 19.0 to 60.0cm (mean = 32.2cm)

Computer versus printed materials.

Differences in:

- Viewing distance
- Gaze angles
- Degree of symptoms
- Blink rate
- Blink amplitude
- Accommodative response.
Computer work v. hard copy

Blink Rates

Measured in 104 office workers:

- When relaxed: 22 per min
- When reading a book: 10 per min
- Viewing text on a computer: 7 per min

(Tsubota and Nakamori New Eng J Med 1993; 328: 584-585)

Is blink completeness a factor?

The completeness of each blink was quantified using the following criteria:

- **Grade 1.** The upper eyelid failed to reach the top of the subject’s pupil while they viewed the computer screen.
- **Grade 2.** The upper eyelid reached the top but failed to reach the bottom of the subject’s pupil while they viewed the computer screen.
- **Grade 3.** No cornea was visible as the subject completed their blink.

A blink score was computed by multiplying the number of blinks in each category by the grade level.

Symptoms versus blink score

N=21; r = 0.462; p=0.035
Does increased blink rate improve CVS symptoms?

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean blink rate (blinks per min)</th>
<th>Total symptom score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metronome</td>
<td>23.45</td>
<td>16.5</td>
</tr>
<tr>
<td>Control</td>
<td>11.29</td>
<td>13.8</td>
</tr>
</tbody>
</table>

P = 0.000

P = 0.33

BUT: Several subjects reported that increased conscious blinking interfered with their ability to perform the task (reading text aloud) satisfactorily.

Comparing accommodation to paper and Ipod (N=15)

Effect of instilling a topical ocular lubricant (N=25)

Total symptom score:
- Ocular lubricant: 11.36 (SEM = 2.70)
- Saline control: 12.00 (SEM = 2.44)

P = 0.79

Differences in Accommodation

- Some suggestion of a larger lag of accommodation when viewing computer screens, compared with printed text, although findings are not consistent across studies.

Conclusions

- Viewing modern electronic screens is NOT the same as reading printed materials.

- Are patients comfortable viewing electronic screens? Not always
CVS: AOA definition

Computer Vision Syndrome (CVS) is the complex of eye and vision problems related to near work which are experienced during or related to computer use. CVS is characterized by visual symptoms which result from interaction with a computer display or its environment. In most cases, symptoms occur because the visual demands of the task exceed the visual abilities of the individual to comfortably perform the task.

% (N=520) reporting symptoms “at least half of the time”.

1. Tired eyes (40%)
2. Dry eyes (32%)
3. Eyestrain or eye discomfort (31%)
4. Irritated or burning eyes (28%).
5. Light sensitivity (26%)

Blur at distance (23%) or near (17%).

So what do we need to know?

1. Complete case history.
   What do they do and where do they do it.

   Ask about:
   • Viewing distance
   • Gaze angle
   • Type and number of devices
   • Font size
   • Task demand

Visual Resolution

• At all relevant distances (especially intermediate and near).

• BOTH high and low contrast (use a low contrast acuity chart).

• Effects of glare.

Measuring effects of glare

• Marco Brightness Acuity Tester (BAT).

Ask about required levels of resolution

• What size stimuli does the patient need to view?

• Three-times rule?
Three-times rule???

To minimize symptoms, it has been suggested that a 3x acuity reserve should be adopted, i.e., the visual acuity should be 3 times better than that required to read the text on the display. Therefore, prolonged viewing of a 20/60 letter would require visual acuity of at least 20/20.

Reading Speed

Number of errors

Three-times rule???

• For visually-normal subjects, a 2x rule is appropriate for sustained comfortable reading.

• So if a patient wants to view 20/20 material for a sustained period of time, they need VA of at least 20/10.

Accommodation testing

• Accommodative response (Cross-Nott dynamic retinoscopy at preferred distance).

• Accommodative facility (monocular and binocular).

• NRA / PRA

Cross-Nott Retinoscopy

• Patient holds target at preferred working distance.

• Perform ret through distance Rx. If see with movement, move back until a neutral reflex is seen.

• If against movement seen, move forward to get neutral.

• Reciprocal of distance from retinoscope to patient equals accommodative response.
Monocular and Binocular Accommodative facility.

- Norms: Monoc >11cpm, Binoc > 8cpm.
- If monoc reduced: accommodative problem.
- If both monoc and binoc reduced: vergence problem.

“Hart Chart”

- Don’t need a special chart.
- Norms: Monoc > 22cpm, Binoc > 16 cpm (double lens flipper values).

Accommodation varies with gaze angle

Treatment of ocular causes:
Accommodation

- MUST consider position of add (especially if bifocal or PAL).

Treatment of ocular causes:
Accommodation

- Consider near add to improve accommodative accuracy.
Clinical Evaluation

- Vergence testing
  - NPC
  - Phorias?
  - Fixation disparity (associated phoria) at appropriate working distance
  - Vergence facility (using both prisms and "Hart Chart")
  - Vergence ranges (NRV /PRV)

Clinical fixation disparity (associated phoria) testing
- Wesson card
- Saladin card

Wesson fixation disparity card

Saladin Near-point card

Clinical vergence facility testing
- Use 12 ∆ base-out & 3 ∆ base-in prism. Subject views vertical line of text and reports when target appears both clear and single. Minimum expected = 15cpm.
Clinical Evaluation

Is a standard clinical near-vision examination at 40cm (16in) using a printed near-point card, positioned in the primary position and viewed via a phoropter, adequate for assessing our patients current visual requirements?

**NO!**

Clinical evaluation

- Virtually impossible to do this through a phoropter.
- Time to get the trial frame and lenses out.
- TF may be more reliable than phoropter anyway for near phoria measurements due to proximal vergence from the phoropter, differences in head and eye position, and restriction of the peripheral visual field.

Refractive treatments

- Optimum Rx at intermediate and near.
- May need to correct smaller ref errors (including astigmatism) than necessary for printed materials.
- S/V versus bifocals versus PALs.
- Multiple pairs may be necessary.
Productivity

- Daum et al (2004) reported that uncorrected refractive errors, particularly astigmatism, has a significant impact on both visual comfort and productivity. Thus, treatment of CVS may have a significant benefit, not only for the patients, but also for their employees and job efficiency.

Dry eye

1. Monitor in primary position - increased corneal exposure.
2. Decreased blink rate - varies with font size, contrast and cognitive demand.
3. Dry office environments (poor HVAC)
4. Worse in females, CL wearers, refractive surgery patients.

Evaluation of Dry eye

- Symptom questionnaires (OSDI and DEQ-5)
- Keratometry
- Schirmer and phenyl red thread tests
- Tear break up time
- Rose bengal and lissamine green
- Tear hyperosmolarity
- Provocative testing
- Blink rate
- Completeness of blink.

Treatment of ocular causes:

Dry Eye

- Improved corneal hydration
- Improved environment
- Improved blinking (especially CL wearers)
- Use of rewetting solutions
- Anti-inflammatory therapy
- Nutritional supplements
- Punctal occlusion

Other treatments

- Improved screen characteristics (contrast, glare, font size).
- Better screen location (viewing distance and gaze angle).

20:20:20 rule

Every 20 minutes, should look at something at least 20 feet away for at least 20 seconds.
COLOR

• Colored plastic overlays have previously been shown to improve reading of printed materials (e.g., Bouldoukian et al., OPO 2002; 22: 55-60.

Use of colored overlays

Compared symptoms and number of reading errors after reading random words on computer screen through either no overlay, a placebo colored overlay (plastic folder) or Cerium overlay for reading disability.

 CVS symptom scores

<table>
<thead>
<tr>
<th></th>
<th>(N=30)</th>
<th>(N=7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cerium overlay</td>
<td>12.83</td>
<td>12.14</td>
</tr>
<tr>
<td>Placebo overlay</td>
<td>17.37</td>
<td>29.86</td>
</tr>
<tr>
<td>No overlay</td>
<td>15.65</td>
<td>28.93</td>
</tr>
<tr>
<td>P</td>
<td>0.47</td>
<td>0.03</td>
</tr>
</tbody>
</table>
SUMMARY

- How many hours do they spend viewing these screens? Up to 16 hours per day.
- Where do they position the screens? Anywhere between 19cm (8”) and 70cm (28”), either in primary gaze or downgaze.

SUMMARY

- How many patients report symptoms while looking at electronic screens?
- Thompson (1998): 64-90%.
- Portello et al (2012): % subjects reporting symptoms at least half the time:
  - 40% tired eyes
  - 32% dry eye
  - 31% eye discomfort

SUMMARY

Also need to consider:
- Size and contrast of text.
- Duration of working time
- Surrounding environment

Finally, don’t forget: Your mother was right. Sit up straight.