What is Eyestrain?

- asthenopia (ICD-9 368.13)

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College of Optometry

Vision Performance Institute
A research consortium supporting “Quality Sustainable Vision”
Computers are nice, but....
Is All Asthenopia the Same?

Jim Sheedy, OD, PhD
John Hayes, PhD
Jon Engle

**Purpose:** To determine if particular sensations or their location vary dependent upon a causative condition.

**Methods:** 20 subjects read short stories under 8 discomfort-inducing conditions. Latin Square ordering.

<table>
<thead>
<tr>
<th>Inducing Condition</th>
<th>Induction Stimulus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refractive Error</td>
<td>Glasses with +2.00 -4.00 X 180 OU</td>
</tr>
<tr>
<td>Convergence Stress</td>
<td>Glasses with +6.00 DS OU. Reading material was placed 16.7 cm from the eyes and page size was reduced</td>
</tr>
<tr>
<td>Upward Gaze</td>
<td>Reading material was located 20-35 degrees above eye level</td>
</tr>
<tr>
<td>Dry Eye</td>
<td>Manually hold eye lids open</td>
</tr>
<tr>
<td>Accommodative Stress</td>
<td>Alternate sentences read through +/-1.50 lenses</td>
</tr>
<tr>
<td>Small Font</td>
<td>5 point font</td>
</tr>
<tr>
<td>Glare</td>
<td>Peripheral glare sources</td>
</tr>
<tr>
<td>Flickering Light</td>
<td>Strobe light run 15 cyc/sec in a dark room</td>
</tr>
</tbody>
</table>
The subject rated the magnitude of each of 9 symptom sensations:

- burning
- ache
- strain
- irritation
- tearing
- blurred vision
- double vision
- dryness
- headache

The subject indicated the location of the sensation:

- around the eyes
- behind the eyes
- front of the eyes
- center of the eyes
- top of the eyes
- bottom of the eyes
- in between the eyes
ANOVA with repeated measures results:
All of the individual symptom sensation measures (except blur) were significantly related to inducing condition. (p values ranged from 0.003 to 0.0001)

Principal factor analysis calculated 2 latent factors:

External Symptom Factor (ESF) and Internal Symptom Factor (ISF)
ESF and ISF grouping of individual symptoms

\[ \text{External Symptom Factor (ESF)} \]
\[ \text{Internal Symptom Factor (ISF)} \]

- Strain
- Ache
- Headache
- Double Vision
- Blur
- Irritation
- Burning
- Dryness
- Tearing

• p values ranged from 0.003 to 0.0001 (except for blur)
Conclusions:

Summary findings

<table>
<thead>
<tr>
<th>Factor</th>
<th>Symptom(s)</th>
<th>Inducing Conditions</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ESF</strong></td>
<td>Burning Irritation Dryness</td>
<td>Dry Eye Glare Up Gaze Small Font Flicker</td>
<td>Front of eyes Bottom of eyes</td>
</tr>
<tr>
<td><strong>ISF</strong></td>
<td>Strain Ache Headache</td>
<td>Accommodative Stress Convergence Stress Refractive Error</td>
<td>Behind the eyes</td>
</tr>
</tbody>
</table>
Dry eyes and VDTs. Tsubota and Nakamori, New Eng J Med 328, 524, 1993

- 104 office workers
- Blink rates (blinks/min)
  - 22 under relaxed conditions
  - 10 reading a book on a table
  - 7 reading text on a VDT
- Exposed ocular surface (cm²)
  - 2.2 under relaxed conditions
  - 1.2 reading a book on a table
  - 2.3 reading text on a VDT
Blink and reading

- Where does the 200 ms blink fit in?

- Typical reading process
  - Fixation – 250 ms
    - 100 ms visual acquisition
    - 150 ms cognitive interpretation
  - Saccade – 40 ms
Orbicularis oculi

- **Inner palpebral portion**
  - 85-90% Type 2 (twitch) fibers
  - Responsible for blinks

- **Outer orbital portion**
  - Probably Type 1 fibers
  - Responsible for eyelid squint
Hypothesis

- Difficult viewing conditions cause eyelid squint
- Eyelid squint causes reduced blink rate
Visual Stress and Eyelid squint

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John Hayes
Methods

- 20 subjects (16-35 yrs of age) screened for
  - 6/6 visual acuity in each eye
  - binocular vision status

- Subjects read passages under conditions that induced visual stress

- ‘barely tolerable limit’
Methods

- Visual stress inducing conditions –
  - Glare
  - Refractive error
  - Low contrast
  - Small font
  - Convergence stress
  - Accommodative stress
  - Up gaze
Outcome measures

- EMG power
- Aperture size
- Discomfort score

- Repeated measures ANOVA to analyze
Results
EMG Power - Stress inducing conditions

![Graph showing EMG Power in different stress conditions. The x-axis represents different conditions: No Stress, Up gaze, Accom, Lo Cont, SmI Fnt, Convg, Glare, Ref err. The y-axis represents Log EMG Power. Each condition has two bars indicating non-stress control and condition, with error bars showing variability. The graph highlights significant differences marked with asterisks.](image-url)
Results
Aperture size - Stress inducing conditions

Log Palpebral fissure height

- No Stress
- Up gaze
- Accom
- Lo Cont
- Sml Fnt
- Convg
- Glare
- Ref err

Non stress control vs Condition
## Summary of p values

<table>
<thead>
<tr>
<th>Conditions</th>
<th>EMG Power</th>
<th>Aperture size</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Stress</td>
<td>0.137</td>
<td>0.016</td>
</tr>
<tr>
<td>Ref err</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Glare</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Lo Cont</td>
<td>0.007</td>
<td>0.130</td>
</tr>
<tr>
<td>Sml Fnt</td>
<td>0.034</td>
<td>0.061</td>
</tr>
<tr>
<td>Up gaze</td>
<td>0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Convg</td>
<td>0.390</td>
<td>0.061</td>
</tr>
<tr>
<td>Accom</td>
<td>0.088</td>
<td>0.059</td>
</tr>
</tbody>
</table>
Inducing Conditions

Group 1
- Refractive error
- Glare
- EMG
- Squint

Group 2
- Low contrast
- Small font
- EMG
- No squint

Group 3
- Convergence stress
- Accommodation stress
- No EMG
- No squint

External Symptoms

Internal Symptoms
Acknowledgment

These studies are supported by Microsoft Corporation