Performance and Comfort in Sustained Reading with Tablet PC for Children

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Computer Display and Visual Comfort

- Accommodation stress has been the main source of visual discomfort in near viewing (Rempel et al., 2007).
- When viewing computer display, a closer distance is adopted, likely leading to discomfort (Tai et al., 2007).
- Young children can accommodate more than adults in near viewing (Duane, 1922), likely leading to greater accommodative stress in computer use.
- After 10 mins viewing, children’s reading performance with PC is the same as paper, but greater discomfort with poorer acuity.
Specific Aims

• Measure performance, behavioral strategy, and viewing symptoms during sustained reading.
• Identify visual abilities impacting viewing performance and comfort.
Methods

• 25 novices (grades 2-3) and 25 advanced reader (grades 7-8)

• Read from paper and tablet PC (10.5” size) in two separate 60-minute reading sessions, with text format and device weight controlled for.

• They were allowed to adopt any posture and take as frequent breaks as they chose to.

• Viewing distance, reading performance, and visual/physical symptoms were analyzed in relation to gender, grade, near point of convergence (NPC), binocular acuity, and stereoacuity.
Testing Setting
Visual Abilities

• Near visual acuity of better eye (poorer: logMAR >= 0, n = 19; better: logMAR < 0, n = 31)
• Near point of convergence or NPC (nearer: < 8.5cm, n = 23; farther: >= 8.5 cm, n = 27)
• Stereoacuity (poorer: >= 30’, n = 18; better: < 30’, n = 32).
Visual Performance

• Viewing distance was measured every 2 mins and averaged for the first, second, and third 20-min intervals.

• Percentages of correct comprehension (one Q per page) and word recall (50% correct word, one each page), and reading speed (words/min for each page), were measured for each session.
## Interactive Effects on Performance

<table>
<thead>
<tr>
<th>Factors Outcomes</th>
<th>Grade</th>
<th>Display</th>
<th>Break</th>
<th>VA</th>
<th>SVA</th>
<th>NPC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Viewing Distance</strong></td>
<td>Adv &gt; novice</td>
<td>Paper &gt; PC</td>
<td>No break</td>
<td>Better &gt; poorer</td>
<td></td>
<td>Far &gt; Near</td>
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<tr>
<td></td>
<td>Adv</td>
<td>Paper</td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>All</td>
<td>Paper &gt; break</td>
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<tr>
<td></td>
<td>All</td>
<td>Paper &gt; break</td>
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<tr>
<td><strong>Text Comp.</strong></td>
<td>All</td>
<td>Paper &gt; PC</td>
<td>Break &gt; no break</td>
<td>Better &gt; poorer</td>
<td></td>
<td>Near &gt; far</td>
</tr>
<tr>
<td></td>
<td>Novice</td>
<td>Paper &gt; PC</td>
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<tr>
<td></td>
<td>All</td>
<td>Paper</td>
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<tr>
<td><strong>Reading Speed</strong></td>
<td>Adv &gt; novice</td>
<td>Paper &gt; PC</td>
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<td>Far &gt; Near</td>
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<td>All</td>
<td>Paper &gt; PC</td>
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<tr>
<td><strong>Word recall</strong></td>
<td>All</td>
<td>Paper &gt; PC</td>
<td>Break &gt; no break</td>
<td>Poorer</td>
<td></td>
<td>Near &gt; Far</td>
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<tr>
<td></td>
<td>Novice</td>
<td>Paper &gt; PC</td>
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<tr>
<td></td>
<td>All</td>
<td>Paper &gt; PC</td>
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<tr>
<td><strong>Break Frequency</strong></td>
<td>Novice &gt; Adv</td>
<td>PC &gt; paper</td>
<td>Poorer &gt; Better</td>
<td>Poorer &gt; better</td>
<td>Near &gt; far</td>
<td></td>
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<tr>
<td></td>
<td>All</td>
<td>PC &gt; paper</td>
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</tbody>
</table>
Advanced Readers

Time intervals

Viewing distance (cm)

1 to 20

21 to 40

41 to 60

w/o break

with break
Acuity and Break on Comprehension

[Bar chart showing correlation rates for paper and PC displays with different conditions: Poorer/noBrk, Poorer/break, Better/noBrk, Better/break. The x-axis represents Display (paper, PC), and the y-axis represents Correlation rate.]
Display and SVA on Word Recall

![Bar chart showing comparison between paper and PC displays for display and SVA on word recall. The chart shows the correlation rate for each display type.](image-url)
Likelihood of Taking Break

Grade

Percentage (%)

Novice

Advanced

Paper

PC
Viewing Symptoms

- **Measurement:**
  - 1: no symptom at all
  - 4: extreme symptom

- **Severity:** all significantly elevated after 60 minutes ...
  - Dry eye (1.6 → 2.3)
  - Eye sore (1.2 → 2.0)
  - Eye strain (1.1 → 1.7)
  - Eye fatigue (1.5 → 2.2)
  - Neck ache (1.2 → 2.0)
  - Arm and shoulder ache (1.1 → 1.6)
## Interactive Effects on Symptoms

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<tbody>
<tr>
<td>Symptoms</td>
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<tr>
<td>Dry eye</td>
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<td>Poorer &gt; better</td>
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<tr>
<td>Sore eye</td>
<td>All</td>
<td>Novice</td>
<td>No break</td>
<td>Poorer &gt; better</td>
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<tr>
<td>Eye fatigue</td>
<td>Novice</td>
<td>PC</td>
<td>No break</td>
<td>Poorer &gt; better Better &gt; poorer</td>
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<tr>
<td>Eye strain</td>
<td>All</td>
<td>Novice</td>
<td></td>
<td>Poorer &gt; better</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neck ache</td>
<td>Novice &gt; adv</td>
<td>PC &gt; paper</td>
<td></td>
<td></td>
<td></td>
<td>Near &gt; far</td>
</tr>
<tr>
<td>Arm/shoulder ache</td>
<td>Novice</td>
<td></td>
<td>No break</td>
<td></td>
<td>Far &gt; Near</td>
<td></td>
</tr>
</tbody>
</table>
Gender and VA on Dry Eye

Symptom score

Testing time

- Male/poorer
- Male/better
- Female/poorer
- Female/better

Pre-test vs. Post-test
Grade and VA on Eye Fatigue

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**Testing time**

- **Pre-test**
  - novice/poorer
  - novice/better
  - advanced/poorer
  - advanced/better

- **Post-test**
  - novice/poorer
  - novice/better
  - advanced/poorer
  - advanced/better

**Symptom score**

- 4
- 3
- 2
- 1

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Grade and VA on Eye Strain

Symptom score

Testing time

pre-test
post-test

 novice/poorer
 novice/better
 advanced/poorer
 advanced/better
Grade and Break on Arm/Shoulder Ache

Testing time

Symptom score

pre-test

post-test

• novice/NoBreak
• novice/Break
• advanced/NoBreak
• advanced/Break
Summary

- Reading performance is affected by display condition and visual abilities in sustained reading, though not in shorter reading.
- Sustained reading heightens all viewing symptoms; display type did not directly affect viewing symptoms.
- Visual abilities and behavioral strategies interact with display type to influence reading performance and viewing symptoms.
Implications

- Display quality influences viewing behaviors, depending on viewer’s skills and visual abilities.
- Viewing symptoms either reflect the direct stress from weaker visual abilities, or from improper behaviors and weaker ability.
- Care should be taken to remedy the direct visual/physical stress and to alter viewing behaviors.