Effects of Visual Demand and In-Vehicle Task Complexity on Driving and Task Performance as Assessed by Visual Occlusion

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1 ISSUES

1. How does task context (driving versus stationary) affect driver performance and behavior for a display-intensive in-vehicle task?
2. How does driving workload affect driver performance and behavior for the in-vehicle task?
3. How do age and gender affect the above?
4. How does the method employed, the voluntary occlusion technique, affect driving performance and is it predictive of glance behavior while performing the in-vehicle display?
5. How does intermittent occlusion of the road-scene affect performance of the in-vehicle task?

2 TEST PLAN

Maps & questions

Task: drive simulator on roads with long curves while providing answers to questions about maps (3 levels of task complexity / response duration)

Subjects

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young (21-30)</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Old (over 65)</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

Position of in-vehicle display

What street are you on?
What street is the fast food restaurant on?
What street intersects with VANESSA at a gas station?
### 3 RESULTS

#### A. Glance dependent measures

- Glancing at the map
- Not glancing at the map

#### B. The effect of age and gender

<table>
<thead>
<tr>
<th>Task completion time</th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young</td>
<td>3.2±2.2</td>
<td>2.9±2.1</td>
</tr>
<tr>
<td>Old</td>
<td>6.1±3.8</td>
<td>7.1±4.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mean glance duration</th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young</td>
<td>1.3±0.3</td>
<td>1.7±0.6</td>
</tr>
<tr>
<td>Old</td>
<td>1.4±0.4</td>
<td>1.5±0.6</td>
</tr>
</tbody>
</table>

#### C. Task context (driving vs. stationary)

- Task completion time generally increased due to driving, but in short tasks, and young drivers, it decreased

#### D. Driving workload (road curvature)

- Mean glance duration decreased with curvature. The effect was larger for longer tasks
3 RESULTS (CONT.)

**E. Voluntary occlusion**

Visual demand increased linearly with curvature. Older subjects had higher values of visual demand. The proportion of time subjects looked at the road in the secondary task and in the occlusion task were linearly related.

**F. Driving performance**

Performing the secondary task caused driving performance to deteriorate. Occlusion resulted in a similar pattern.

**G. Intermittent occlusion of the road scene**

Occluding the road when subjects looked at the in-vehicle display resulted in a decrease in total glance duration.
3 RESULTS (CONT.)

H. Subjective ratings

- Mean estimation for glance time at a map with no adverse effects on driving was 2.1 [s]
- Perceived task difficulty increased when the map task was added, and more so when the road was occluded

4 CONCLUSIONS

- Task context (driving versus stationary)
  - Task completion time increased when performed while driving (but decreased for short tasks)
  - Total glance duration remained constant (but decreased for short tasks)

- Driving workload (road curvature)
  - Task completion time did not change significantly as a function of road curvature
  - Mean glance duration decreased and the number of glances increased in sharper curves
  - Driving performance declined as curve became sharper

- Age and gender
  - Older drivers made more glances, their mean time between glances were longer and their task completion times were longer
  - The mean glance duration did not vary as a function of age
  - Older drivers' driving performance was worse

- Voluntary occlusion
  - Visual demand, as measured in the visual occlusion technique, predicted glance behavior while performing the in-vehicle task
  - The decline in driving performance with occlusion was similar to the decline with the in-vehicle task

- Intermittent occlusion of the road scene
  - Occluding the road whenever subjects looked at the in-vehicle display resulted in shorter glances
  - Task completion time did not change
  - Subjects chose to make more efficient glances as a result of the lack in peripheral input