Mitigating cognitive distraction and its effects with interface design and collision avoidance systems

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**IIHS** is an independent, nonprofit scientific and educational organization dedicated to reducing the losses — deaths, injuries and property damage — from crashes on the nation’s roads.

**HLDI** shares this mission by analyzing insurance data representing human and economic losses from crashes and other events related to vehicle ownership.

Both organizations are wholly supported by auto insurers.
In the current driving environment, completely mitigating cognitive distraction is unlikely

- Effective mitigation implies being able to identify the targeted behavior reliably

- Analyses of phone conversations during naturalistic driving studies exemplify the challenge of identifying/measuring cognitive distraction
  - Lack of increased crash\near-crash risk associated with ‘just talking’ on a phone in naturalistic studies (e.g., Farmer et al, 2014a; Fitch et al 2013)
  - Drivers tend to look out the front windshield and at the mirrors more when ‘just talking’ (e.g., Farmer et al. 2014b)
When talking on the phone, drivers tended to avoid all other secondary behaviors except holding another object.
Vehicle infotainment interface design
Identifying interface design features that limit driver workload

- IIHS – MIT Agelab collaborative field experiment (Mehler et al., 2015; Reimer et al., 2015)

- To what extent do different implementations of in-vehicle infotainment systems affect driver workload (Knowles, 1963)?
  - How easy is this equipment to operate?
  - How much attention is required?
Steps needed to call a phone contact for one-shot (2013 Chevrolet MyLink) and menu-based (2013 Volvo Sensus) voice interfaces

<table>
<thead>
<tr>
<th>voice interface</th>
<th>system</th>
<th>visual or manual steps</th>
<th>auditory or vocal steps</th>
<th>total steps</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Chevrolet Mylink</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Volvo Sensus</td>
<td>3</td>
<td>4</td>
<td>7</td>
</tr>
</tbody>
</table>
Evaluation of workload during highway driving

- 80 naive volunteer drivers ages 20-66 years
  - 40 used Volvo’s Sensus
  - 40 used Chevrolet’s MyLink
- Drove 65 mph on an interstate while:
  - Calling contacts in phone book using manual and voice interfaces
  - Entering destinations into navigation system using voice interface
Drivers made phone calls fastest, on average, when using the one-shot MyLink voice interface.
MyLink’s one-shot approach resulted in more errors when entering addresses than Sensus’s menu-based approach.

Percent of address entry trials with errors

![Bar chart showing the percentage of address entry trials with errors for Chevy MyLink and Volvo Sensus. Chev MyLink shows a high percentage of user error and system error compared to Volvo Sensus, which has a lower percentage of user error and a negligible system error.]
Voice interaction reduced self-reported workload when error rate was low.
Crash avoidance systems
Crash avoidance technologies can eliminate or mitigate the effects of distraction

- Provide safety-relevant warnings to redirect wandering attention
- Reduce attentional demand or increase safety margins to reduce consequences of cognitive distraction
- Prevent or mitigate crashes by taking action when driver fails to act appropriately to prevent a crash (e.g., automatic braking, electronic stability control)
Property damage liability claim frequency is consistently lower for vehicles with front crash prevention relative to the same or similar make/model vehicles without front crash prevention.

<table>
<thead>
<tr>
<th></th>
<th>low speed autobrake</th>
<th>warning only</th>
<th>warning with autobrake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volvo City Safety</td>
<td>-30%</td>
<td>-20%</td>
<td>-10%</td>
</tr>
<tr>
<td>Honda Accord camera</td>
<td>-20%</td>
<td>-10%</td>
<td>0%</td>
</tr>
<tr>
<td>(with LDW)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Honda Accord radar</td>
<td>-10%</td>
<td>0%</td>
<td>10%</td>
</tr>
<tr>
<td>(with LDW + ACC)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mercedes</td>
<td>0%</td>
<td>10%</td>
<td>20%</td>
</tr>
<tr>
<td>Volvo</td>
<td>10%</td>
<td>20%</td>
<td>30%</td>
</tr>
<tr>
<td>Acura</td>
<td>20%</td>
<td>30%</td>
<td>40%</td>
</tr>
<tr>
<td>Mercedes</td>
<td>30%</td>
<td>40%</td>
<td>50%</td>
</tr>
<tr>
<td>Subaru (with LDW)</td>
<td>40%</td>
<td>50%</td>
<td>60%</td>
</tr>
<tr>
<td>Volvo (with LDW)</td>
<td>50%</td>
<td>60%</td>
<td>70%</td>
</tr>
</tbody>
</table>
Summary

- The biggest challenge to reducing or eliminating cognitive distraction is that we cannot, from a practical perspective, reliably identify the phenomenon when it is occurring.
- Human factors research can inform interface design so drivers experience minimal cognitive demand when interacting with vehicle interfaces.
- Crash avoidance technologies show a lot of promise in reducing crashes associated with distraction irrespective of the source (e.g., manual, visual, cognitive).
More information and links to our YouTube channel and Twitter feed at iihs.org

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References

1. Farmer et al. (2014a). Relationship of near-crash/crash risk to time spent on a cell phone while driving. IIHS, Arlington, VA.


6. Reimer et al. (2015). Multi-modal demands of a smartphone used to place calls and enter addresses during highway driving relative to two embedded systems. IIHS, Arlington, VA.