Cognitive Attention and Its Application in Countermeasures on a Curve Section

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Problem Statement and Objective

- **Cause of premature death:** motor vehicle crashes
- **Causes of 90% traffic crashes:** human errors – visual information processing
- **Attention-related issues:** inattention, distracted attention, and “looked but failed to see”

This study aims to:
- Propose a methodology to evaluate the effectiveness of countermeasures of traffic safety based on drivers’ cognitive attention and driving performance.

Methodology

- **Eye tracker:** Tobii eye tracker 4C with upgrade key
- **Driving simulator:** STISIM M100
- **Traffic simulation:** Paramics

Driving Simulation and Scenario Modeling

- **Case:** two-lane rural curve (Cypress Lake Road, Statesboro, GA)
- **Curve type:** horizontal and vertical curves; right and left curves
- **Length:** 3000ft (0.57 mile)
- **Road Grade:** 30ft difference at first 0.4 mile
- **Traffic flow:** light traffic and heavy traffic
- **Weather:** clear and fog

Table 1. Countermeasures and Runs

<table>
<thead>
<tr>
<th>Runs</th>
<th>Countermeasures in each run</th>
<th>Countermeasures</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>C1</td>
<td>C1=Centerline Pavement Marking</td>
</tr>
<tr>
<td>R2</td>
<td>C1, C2</td>
<td>C2=Edge Line Pavement Marking</td>
</tr>
<tr>
<td>R3</td>
<td>C1, C2, C3</td>
<td>C3=Shoulder Rumble Strips</td>
</tr>
<tr>
<td>R4</td>
<td>C1, C2, C4</td>
<td>C4=Flexible delineator posts</td>
</tr>
<tr>
<td>R5</td>
<td>C1, C2, C5</td>
<td>C5=Posted Speed Sign</td>
</tr>
<tr>
<td>R6</td>
<td>C1, C2, C6</td>
<td>C6=Curve Warning Sign</td>
</tr>
<tr>
<td>R7</td>
<td>C1, C2, C7</td>
<td>C7=Curve Speed Warning Sign</td>
</tr>
<tr>
<td>R8</td>
<td>C1, C2, C8</td>
<td>C8=Increased Shoulder Width</td>
</tr>
<tr>
<td>R9</td>
<td>C1, C2, C9</td>
<td>C9=Changed Horizontal Curve Curvature</td>
</tr>
<tr>
<td>R10</td>
<td>C1, C2, C10</td>
<td>C10=Decreased Curve Grade on Negative Grade</td>
</tr>
<tr>
<td>R11</td>
<td>C1, C2, C11</td>
<td>C11=Increased Curve Grade on Positive Grade</td>
</tr>
</tbody>
</table>

Findings and Conclusion

**Comparison using Analysis of Variance**
- **Significant differences** among the countermeasures and weather and traffic flow of:
  - Eye movement (cognitive attention)
  - Driving performance
  - Short-term memory

**Visualization of Attention**
- Most participants focused their attention on the roadway.

**Relationship between Countermeasures and Safety**
- **Effective countermeasures:**
  - Edge line pavement marking
  - Shoulder rumble strips
  - Flexible delineator posts
  - Curve warning sign
  - Increased shoulder width
- **Weather and traffic flow:**
  - Foggy weather with heavy traffic flow: most dangerous
  - Clear weather and no traffic flow: most safe

Conclusion

- The proposed methodology can evaluate the effectiveness of countermeasures considering cognitive attention and driving performance to improve traffic safety.