Validation of a signalization scheme for road works at a roundabout (simulator study)

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Introduction
European Commission: [1]

- “Calls on the Commission to ensure that road work sites are made safer through guidelines for designing and equipping sites [...];
- Calls for guidelines, which should include proper signing, removal of original road markings [...]”
Introduction

- Road works
  - Standard signalization schemes for road works
    - Six categories
      - Eg. $50 \text{ km/h} < \text{ speed limit } \leq 90 \text{ km/h}$
        - At a roundabout
        - With traffic lights at the branches

Validation

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Introduction

- Effectiveness of signalization depends on [2]

Sign detection  Sign readability

Sign comprehension
Introduction

- Research questions
  - Is the signalization *comprehensible*?
  - Is the behavior of the drivers *correct*?
    - Destination reached?
Method
Method

- Expert judgement
- Simulator
  - Fixed-based simulator
  - NADS MiniSim™ v2.0
- 7 experimental trips

<table>
<thead>
<tr>
<th>Origin</th>
<th>South (Bekkevoort)</th>
<th>West (Kortenaken)</th>
<th>North (Geetbets)</th>
<th>East (Glabbeek)</th>
</tr>
</thead>
<tbody>
<tr>
<td>South (Bekkevoort)</td>
<td>n/a</td>
<td>Route 1</td>
<td>Route 2</td>
<td>//</td>
</tr>
<tr>
<td>West (Kortenaken)</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>North (Geetbets)</td>
<td>Route 3</td>
<td>Route 4</td>
<td>n/a</td>
<td>Route 5</td>
</tr>
<tr>
<td>East (Glabbeek)</td>
<td>Route 6</td>
<td>Route 7</td>
<td>//</td>
<td>n/a</td>
</tr>
</tbody>
</table>

Instruction:
- Drive as you normally do
- Before every trip: Go to …
Temporary signalization (the same for every branch)
- Only during road works
- **Temporary signalization** (different for every branch)
  - Only during road works
    - Lane separation
    - Advance direction sign (100 m before temporary traffic light)
  - At 3-way intersection
Method

- Specific signalization
  - Always present
    - Advance direction sign (200 m before roundabout)
      - 1 direction is occluded
Results & conclusion
Results and Conclusion

- 50 participants
  - 2 simulator sick ➔ 48 participants

<table>
<thead>
<tr>
<th></th>
<th>Average</th>
<th>σ</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age [years]</td>
<td>37.9</td>
<td>16.9</td>
<td>20</td>
<td>69</td>
</tr>
<tr>
<td>Driving licence [years]</td>
<td>17.8</td>
<td>16.6</td>
<td>1</td>
<td>48</td>
</tr>
<tr>
<td>% male</td>
<td></td>
<td></td>
<td>62.5%</td>
<td></td>
</tr>
</tbody>
</table>
Results and Conclusion

- For each (7) route
  - Description of ‘route without roadworks’ and ‘route with routeworks’
  - Analysis of driven route (Chi square test)
    - Correct ↔ incorrect
  - Recommendations
Route 1: From south (Bekkevoort) to west (Kortenaken)

- **Without roadworks:** normal use of roundabout

- **With roadworks:** next three-way intersection
- **19% incorrect** \( (p < .0001) \)
  - Straight on at 3-way intersection

- **Recommendation**
  - Changing temporary *general* direction sign (diversion) by *specific* direction sign (city name)

Verbal comment of 78% of incorrect (7/9): **city name on temporary direction sign is better**
Route 2

Route 2: From south (Bekkevoort) to north (Geetbets)

- No differences:
  - Without roadworks = with roadworks
- **12% incorrect** \( (p < 0.0001) \)
  - Leftwards at 3-way

- **Recommendation**
  - Changing temporary *general* direction sign (diversion) by *specific* direction sign (city name)
  
  - Extra temporary advance direction sign

Verbal comment: 67% of incorrect (4/6): **followed**
*general diversion sign*
Route 6: From east (Glabbeek) to south (Bekkevoort)

- **Without roadworks:**
  normal use of roundabout
  = Counterclockwise

- **With roadworks:**
  not normal use of roadworks
  = Clockwise
- **77% incorrect** (p < .0001)
  - To the north

- **Recommendation**
  - Changing specific temporary signalization (clockwise) (2 possibilities)
    - Follow-up study (2017): 0 to 8% wrong

Verbal comment of 68% of incorrect (25/37): **not clear that roundabout is not complete** and **not clear to use it clockwise**
Results and Conclusion

- Validation
  - 1 important adaptation needed
  - 11 smaller recommendations

➔ Make detour signs
  - (1) as clear as possible
  - (2) as specific as possible
Thank you for your attention
References
