Efficacy of Traffic Management Measures: The Influence of Complexity of Driving Conditions

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Outline

• Introduction;

• Introducing a theoretical framework of adaptation effects in relation to complexity;

• Method;

• Results;

• Conclusion;
Introduction

• Complexity of driving conditions has been shown to have a substantial impact on driving behavior;

• E.g. Brookhuis et al. (1991), Horrey et al. (2009);

• Therefore an impact on the efficacy of traffic management measures may be assumed (see for instance Hoogendoorn et al. (2011);

• However: how is complexity of driving conditions actually related to these adaptation effects in driving behavior?
Introducing a theoretical framework

- Governed by an interaction between driver capability and task demands;

- Driver capability:
  - Driver characteristics;
  - Activation level;
  - Distraction;

- Task demands: difficulty of the driving task;

- Adverse condition: an imbalance between task demands and driver capability occurs;
Introducing a theoretical framework\textsuperscript{2}

- To resolve this imbalance: compensation effects;
- E.g. Speed reductions, increase in spacing
- When insufficient, performance effects;
- E.g. perceptual narrowing, longer inter-decision times, etc;
Introducing a theoretical framework\(^3\)
Research questions

• However:

• To what extent does complexity of driving conditions influence compensation effects in longitudinal driving behavior, represented by changes in speed and spacing?

• To what extent does complexity of driving conditions influence perceptual thresholds with regard to relative speed and spacing?

• To what extent does complexity of driving conditions influence the sensitivity of accelerations towards relative speed and spacing?

• To what extent does complexity of driving conditions influence inter-decision times?
Method

- Driving simulator experiment with a repeated measures design;
- Virtual motorway with three lanes in the same direction;
- Control condition (normal driving conditions);
- Experimental condition (concrete barriers and narrow lanes);
- 25 participants (mean age: 29.68, SD=6.93, mean driv, experience: 9.6, SD=7.50);
Method²

- Analysis compensation effects in empirical longitudinal driving behavior through paired samples t-tests;

- Analysis of performance effects through:

  - Estimation of action points in relative speed spacing plane (perceptual thresholds): Hoogendoorn et al. (2011);

  - Establishing sensitivity of acceleration towards relative speed / spacing at these action points:

    \[ a = b_1 \frac{\Delta v}{\sqrt{s}} + b_2 \Delta v \]

- Establishing elapsed time between accelerations (inter-decision times);
Results – Compensation effects

- Substantial and significant effects of complexity on empirical longitudinal driving behavior;
- Significant compensation effects in speed $v$ and spacing ($p < .05$);
Results – Performance effects

- Changes in perceptual thresholds;
- In the complex conditions drivers react predominantly to larger speed differences and at larger spacings!
Results – Performance effects

- Sensitivity of accelerations to relative speeds and spacing;
  \[ a = b_1 \frac{\Delta v}{\sqrt{s}} + b_2 \Delta v \]

<table>
<thead>
<tr>
<th></th>
<th>(b_1)</th>
<th>(b_2)</th>
<th>MSE</th>
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<tr>
<td>Control condition</td>
<td>0.28</td>
<td>0.02</td>
<td>0.85</td>
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<tr>
<td>Experimental condition</td>
<td>0.18</td>
<td>0.08</td>
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- Drivers become less sensitive towards especially relative speed;
Results – Performance effects

- In the control condition the inter-decision times amounted to 0.58s (SD=0.46), while in the experimental condition they were 0.76s (SD=0.63);
- Significant difference between conditions!
Conclusion

- Framework: interaction between driver capability and task demands lead to compensation effects and performance effects;
- Indeed substantial effects in empirical longitudinal driving behavior: compensation effects;
- Also performance effects due to complexity:
  - Change in perceptual thresholds;
  - Changes in sensitivity towards relative speed;
  - Change in inter-decision times;
  - In the evaluation of traffic management measures these effects should be taken into account;
Questions

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