Driver assistance can increase traffic safety
Brake reaction time, subjective ratings measured
Scenarios differ significantly in situation criticality:
Adaptive to situation criticality & driver reaction
Drivers learn to brake faster over repeated trials
Mean brake reaction time [s]
T1 T2 T3
W1 scenarios
OH (n = 8)
LS (n = 11)
W2 scenarios
PI (n = 4)
PS (n = 11)
4 trials (T) each of one less & one rather critical scenario
Repetition: T1 without, T2+T3 with assistance (learning)
New scenarios: T4 with assistance (transfer)

Results
Manipulation check (15-point rating scale; Heller, 1982)
Scenarios differ significantly in situation criticality:
W1 scenarios: M_h = 7 (“moderate”), 95% CI (6.1, 7.9)
W2 scenarios: M_h = 14 (“very high”), 95% CI (13.5, 14.5)

Learning effect (T1-T3)
Significant interaction & main effects of within-subjects factor trial & between-subjects factor scenario for W1 & W2 scenarios (significant post-hoc tests in all trial comparisons)

Transfer effect (T2 & T4)
Significant main effects of between-subjects factors trial & scenario for W1 scenarios
Initial brake reaction time in T2 in W2 scenarios already low

System acceptance (Van der Laan, Heino, & De Waard, 1997)
Positive system acceptance rating on a scale from -2 to +2:
Usefulness: M all = 1.1, 95% CI (0.9, 1.3)
Satisfaction: M all = 0.7, 95% CI (0.5, 0.9)
No significant differences before & after system experience

Method
Multi stage collision warning in head-up display (HUD)
Adaptive to situation criticality & driver reaction

<table>
<thead>
<tr>
<th>Warning stage</th>
<th>Aim</th>
<th>Timing</th>
<th>Visual</th>
<th>Acoustic</th>
</tr>
</thead>
<tbody>
<tr>
<td>W1 Warning</td>
<td>Moderate decelerating</td>
<td>2 s ≤ x &lt; 8 s</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>W2 Urgent warning</td>
<td>Emergency braking</td>
<td>x &lt; 2 s</td>
<td>-</td>
<td>1 kHz “Beep”</td>
</tr>
</tbody>
</table>

4 urban scenarios of varying criticality
Warning stage | Location | Lead vehicle (L) | Obstacle (O) | Pedestrian (P) |
Picture | W1 Warning | W2 Urgent warning |

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Lead vehicle (L)</th>
<th>Obstacle (O)</th>
<th>Pedestrian (P)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>Straight (S)</td>
<td>Hill (H)</td>
<td>Intersection (I)</td>
</tr>
</tbody>
</table>

Transfer effect (T2 & T4)
Significant main effects of between-subjects factors trial & scenario for W1 scenarios
Initial brake reaction time in T2 in W2 scenarios already low

<table>
<thead>
<tr>
<th>Warning stage</th>
<th>Aim</th>
<th>Timing</th>
<th>Visual</th>
<th>Acoustic</th>
</tr>
</thead>
<tbody>
<tr>
<td>W1 Warning</td>
<td>Moderate decelerating</td>
<td>2 s ≤ x &lt; 8 s</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>W2 Urgent warning</td>
<td>Emergency braking</td>
<td>x &lt; 2 s</td>
<td>-</td>
<td>1 kHz “Beep”</td>
</tr>
</tbody>
</table>

4 trials (T) each of one less & one rather critical scenario
Repetition: T1 without, T2+T3 with assistance (learning)
New scenarios: T4 with assistance (transfer)

Driving simulator experiment (fixed-base)
Brake reaction time, subjective ratings measured
N = 24 drivers (M = 27 years, SD = 8 years)

Conclusion
Multi stage collision warning system is
Beneficial in various critical situations
Well accepted
Drivers learn to brake faster over repeated trials
Reduced accident severity
Positive transfer of assistance experience to new situations is possible
Practice with assistance is recommended to maximize its benefits

Practice makes perfect
Driving experience with a multi stage warning system

Motivation
- Driver assistance can increase traffic safety
- As safety-critical situations can be diverse, integrated adaptive warnings (like a multi stage collision warning) need to be developed and examined in a variety of situations over time

Research questions
1) How much can drivers benefit from such a system over time (learning)?
2) Can drivers transfer learned knowledge to new situations?
3) How is the warning system accepted by drivers before and after experiencing it?

Susann Winkler, Juela Kazazi & Mark Vollrath
Technische Universität Braunschweig | Institute of Psychology | Department of Engineering and Traffic Psychology
susann.winkler@tu-braunschweig.de


