

Visual Longitudinal and Lateral Driving Assistance in the Head-Up Display of Cars

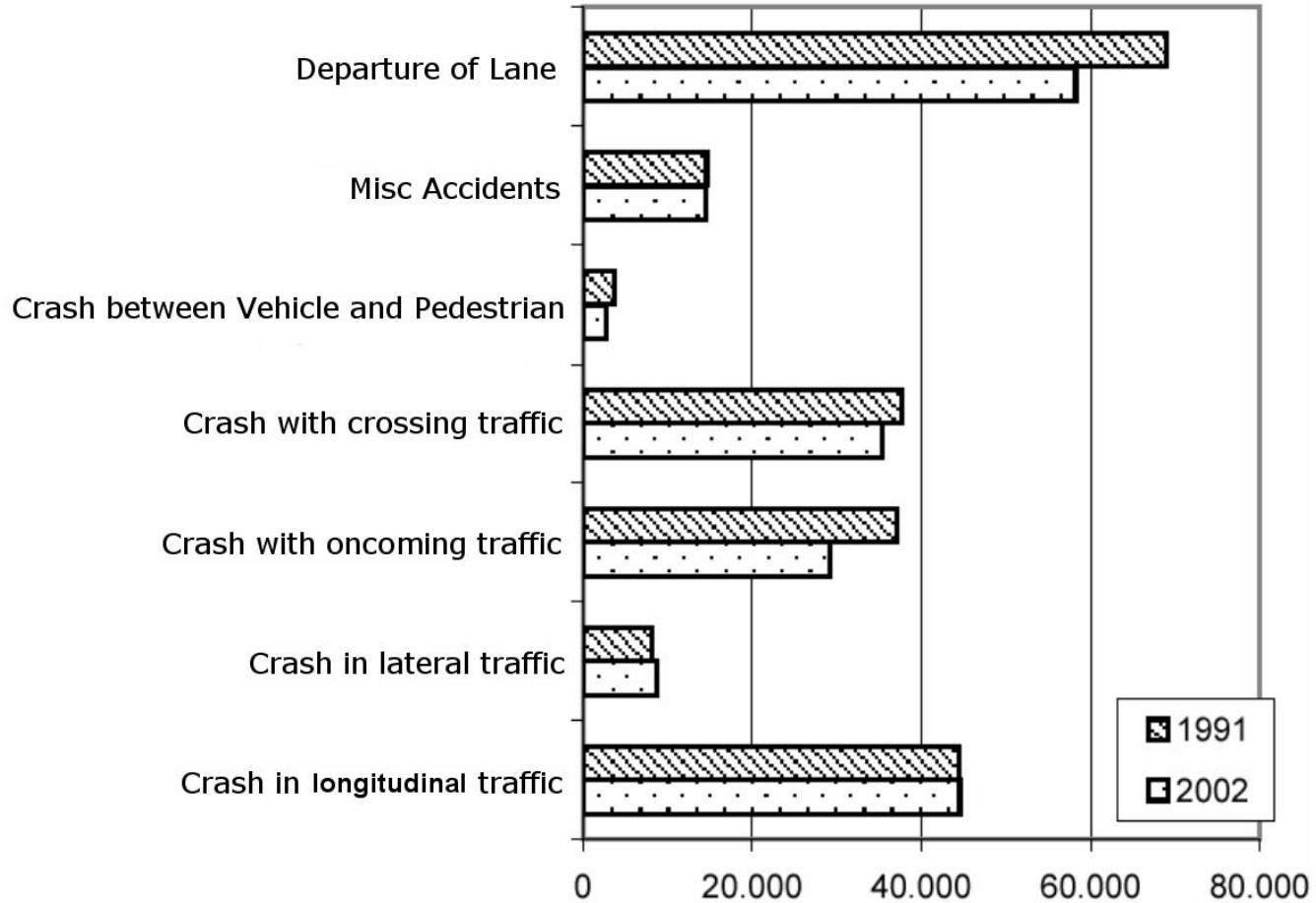
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Reasons for Accidents

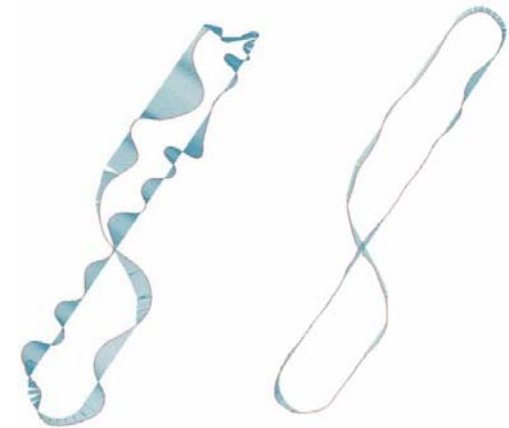


▫ DeStatis - Statistisches Bundesamt, Unfallgeschehen im Strassenverkehr 2002

Overview

- Aids for Spatial Surveillance (Related Work)
- Concepts:
 - Braking Bar Scheme
 - Drive-Path Scheme
- Experiment in a Driving Simulator
- Discussion of Results
- Outlook

Aids for Spatial Surveillance

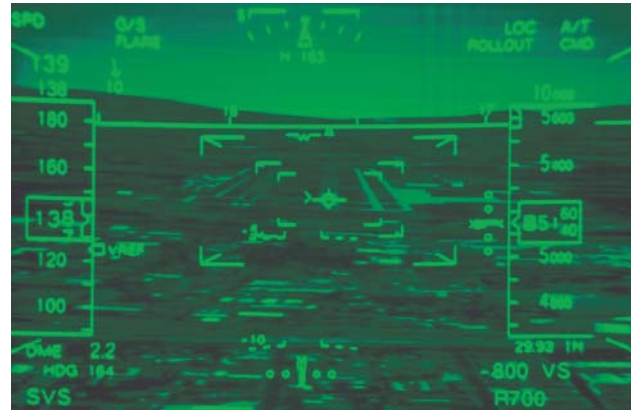


▫ B. Sullivan, C. Ware, and M. Plumlee. *Predictive Displays for Survey Vessels*. In 50th HFES, pages 2424–2428, October 2006

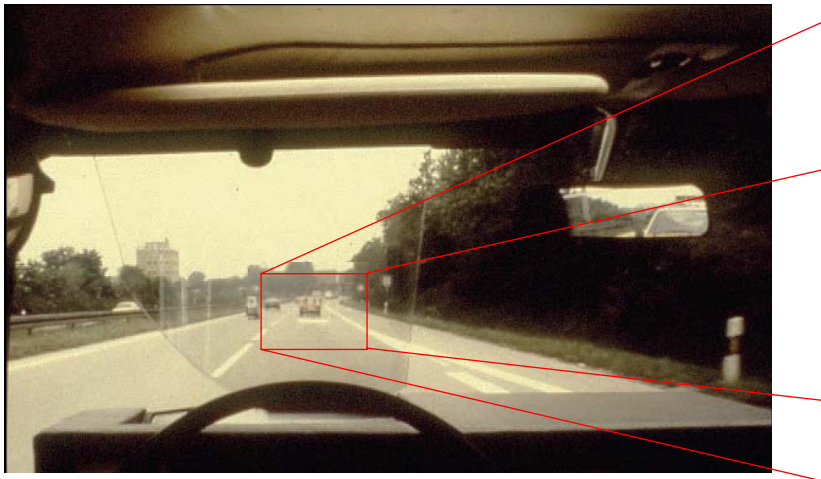


▫ MobileEye. <http://www.mobileye.com/>

Aids for Spatial Surveillance (II)



- L. J. Kramer., L. J. Prinzel III, J. J. Arthur III, and R. E. Bailey. *Pathway Design Effects on Synthetic Vision Head-up Displays*. In SPIE, p. 61–72, NASA Langley Research Center, Hampton, VA, USA, 2004. Volume 5424.



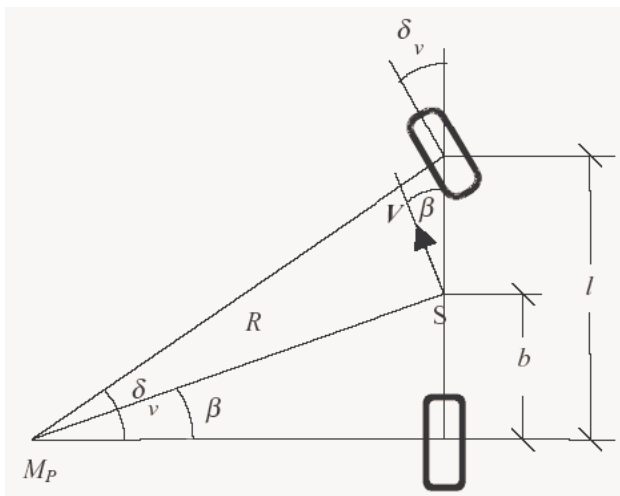
- H. Bubb. *Untersuchung über die Anzeige des Bremsweges im Kraftfahrzeug*. In BMWg, FBWT-7, TU München, Ergonomics, 1976.

General Concept

- Augmented Environment: Integrated approach – no secondary glances required
- In the loop of the control circuit : No warnings – continuous, ambient information
- Focal depth: Virtual image in same distance as covered road area – no time required to focus on assistance scheme
- Scheme color: Bright green – good contrast for visibility
 - In HUD
 - In front of road's concrete

Concept 1: Braking Bar Assistance Scheme

- Longitudinal guidance – Indicates Braking point
- Flat box, 2 cm high, 50 cm long, width of own car
- Mathematical model: Single track driving dynamics



Longitudinal Movement



Longitudinal
Movement

Lateral Movement



Concept 2: Drive-Path Assistance Scheme

- Flight-tunnel presentation for lateral guidance
- Two additional sets of polygons that connect bar and car
- Four vertices
- Indicates area to be covered up to braking point



Experiment

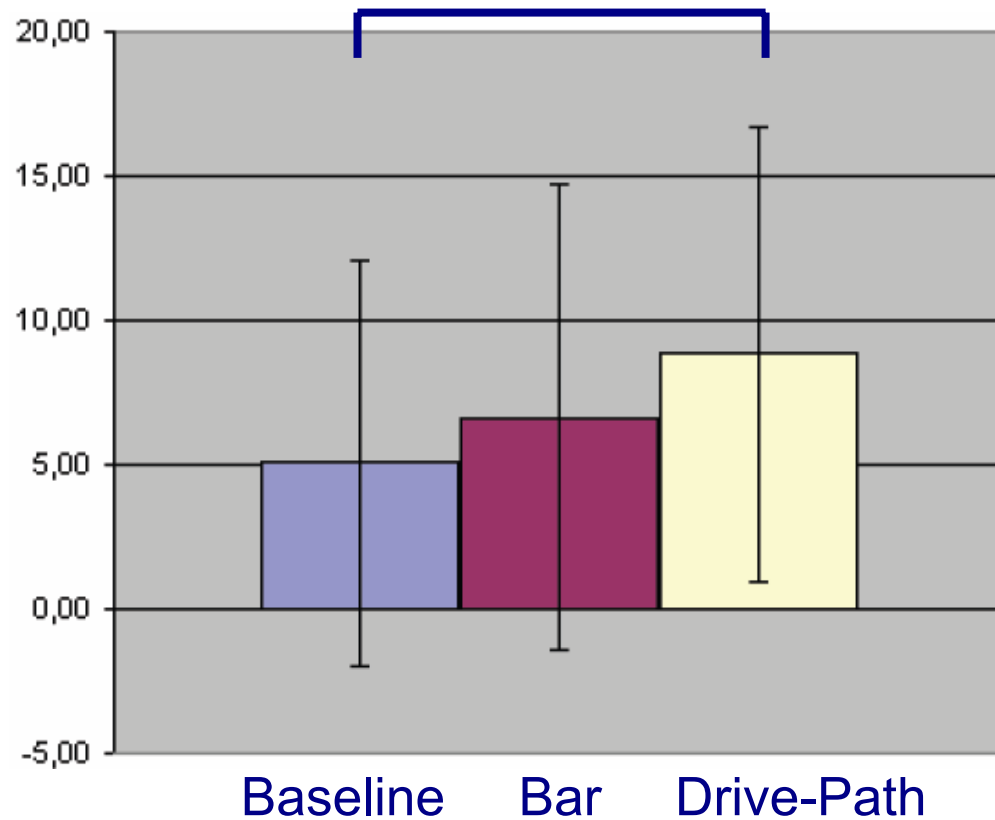
- 27 test participants (mean age 41.3 years, std. dev. 14.8, 14 male, 13 female)
- Fixed base driving simulator, projection wall 3.4 m in front of driver, 40 degree FOV
- Conformal HUD: Focal plane in same distance as projection wall

Experimental Design

- Independent variable: Concept
 - No assistance (baseline)
 - Braking bar scheme
 - Braking bar and drive-path scheme
- Dependent variables
 - Driving performance
 - Speed
 - Lane position
 - Subjective measures
- Significances through ANOVA and T-Test: $\alpha = 0.05$

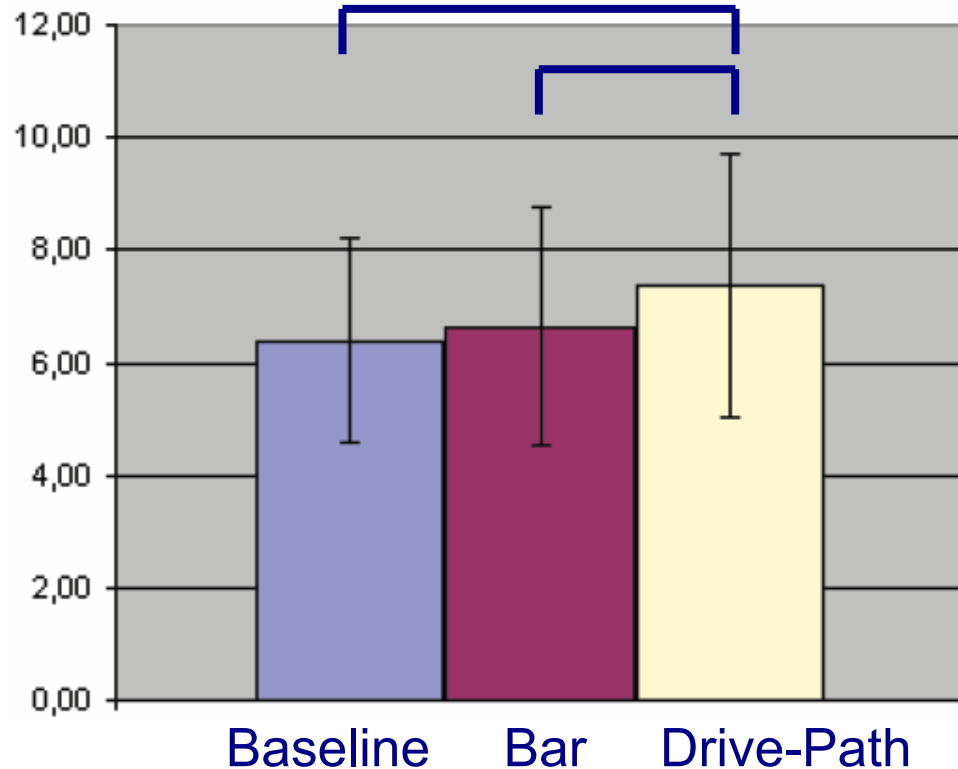
Results: Exceedence of Allowed Speed

Drivers exceeded speed limit the higher the grade of visual assistance



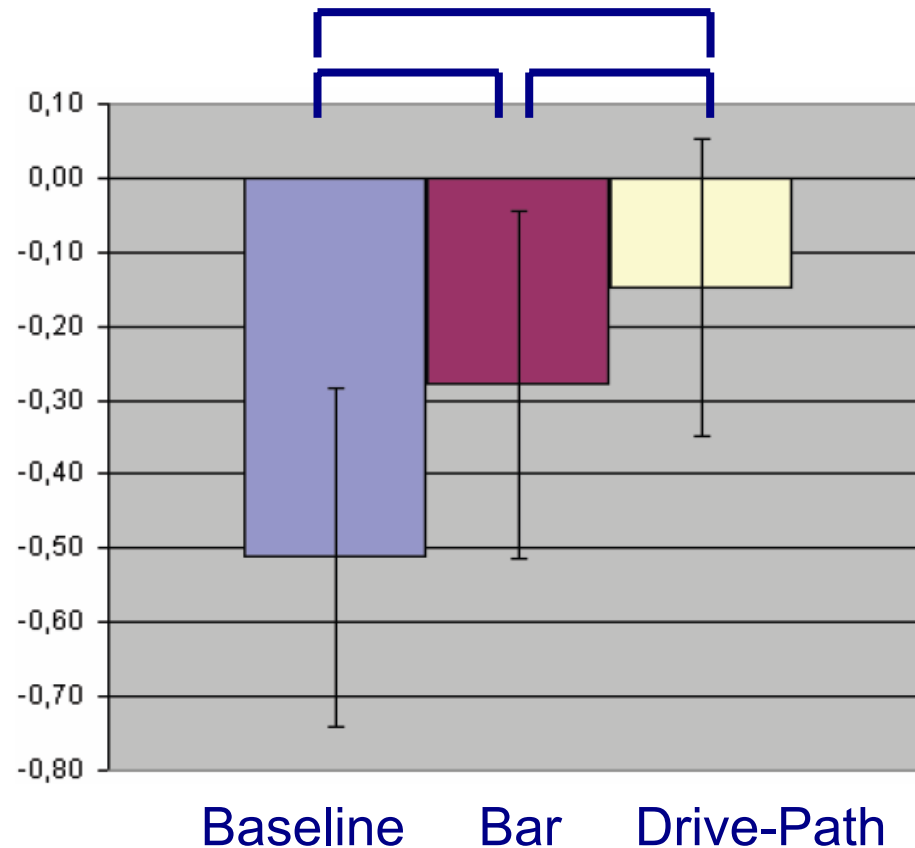
Results: Oscillations in Driven Speed

Larger degree of visual assistance correlates with higher oscillations in driven speed



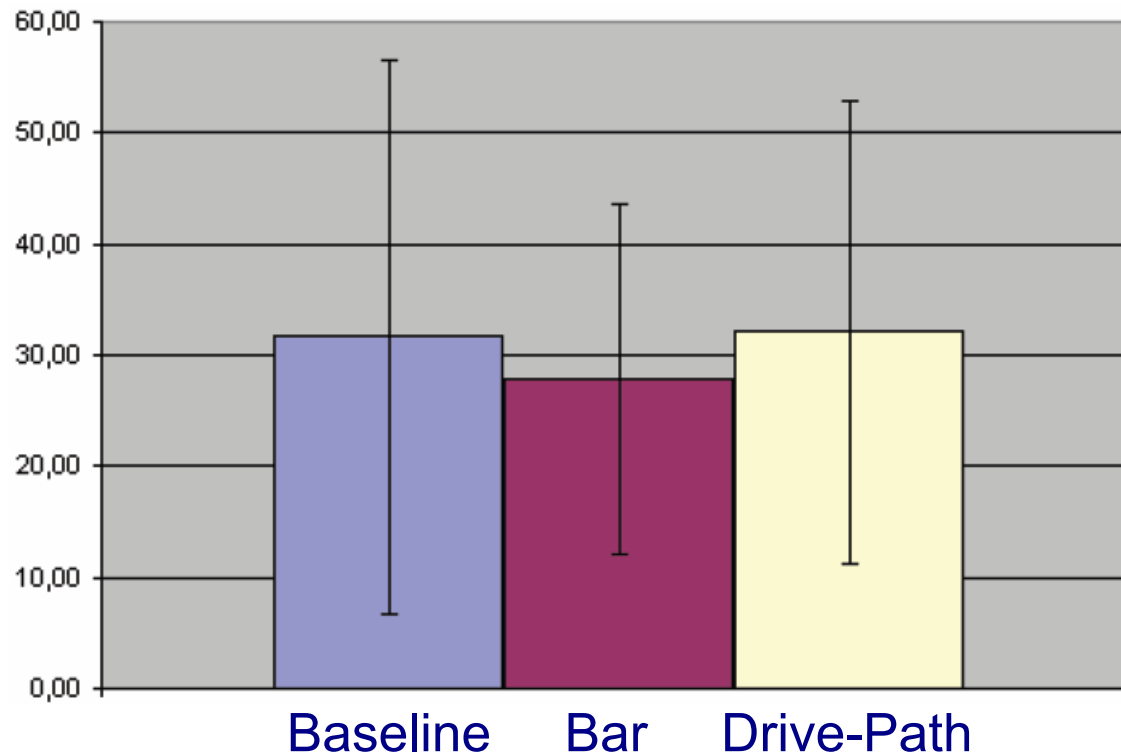
Results: Lane keeping Behavior

The more visual assistance the better the lane keeping behavior



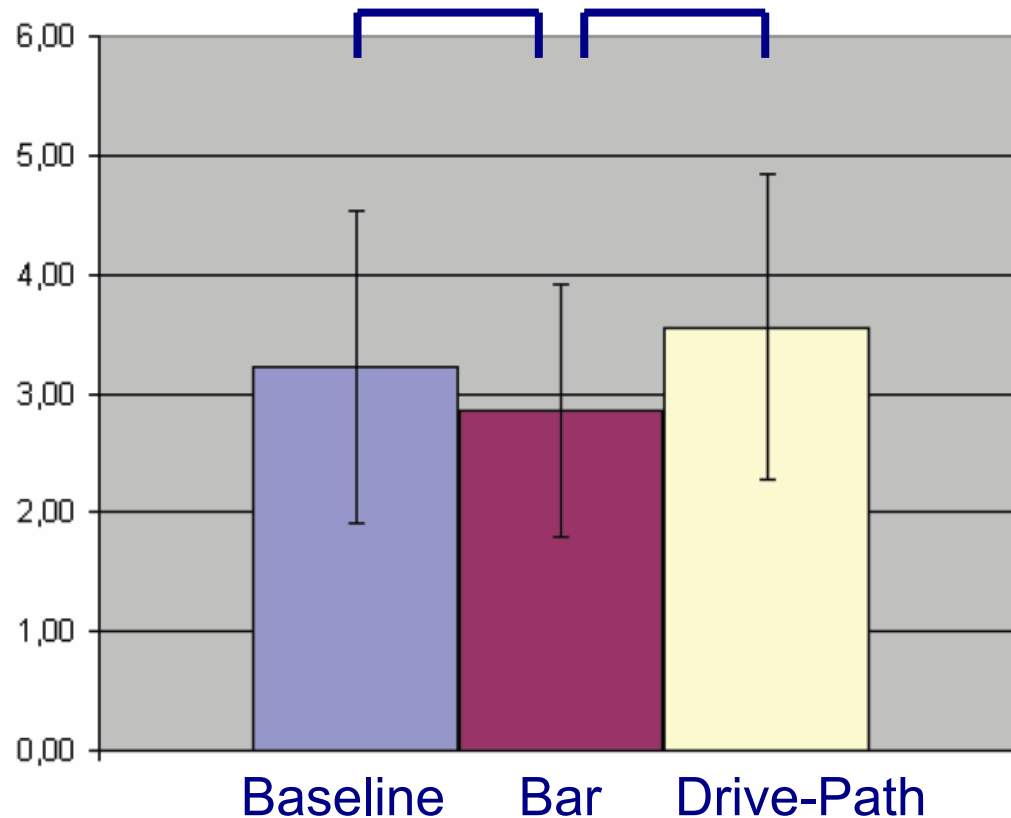
Subjective Measurements: *NASA Task Load Index*

- Computed Overall Workload Index on scale 0-100



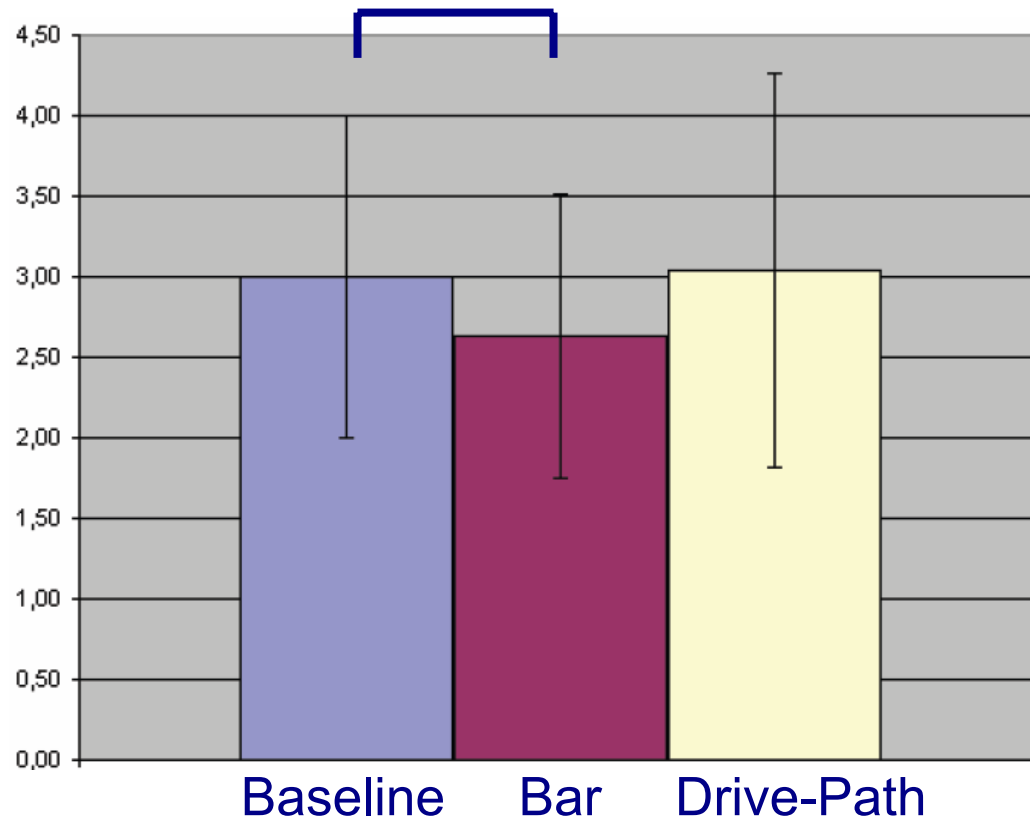
Subjective Measurements: Capability to Maintain Speed

German school grade system, ranging from 1 (best) to 6 (worst)



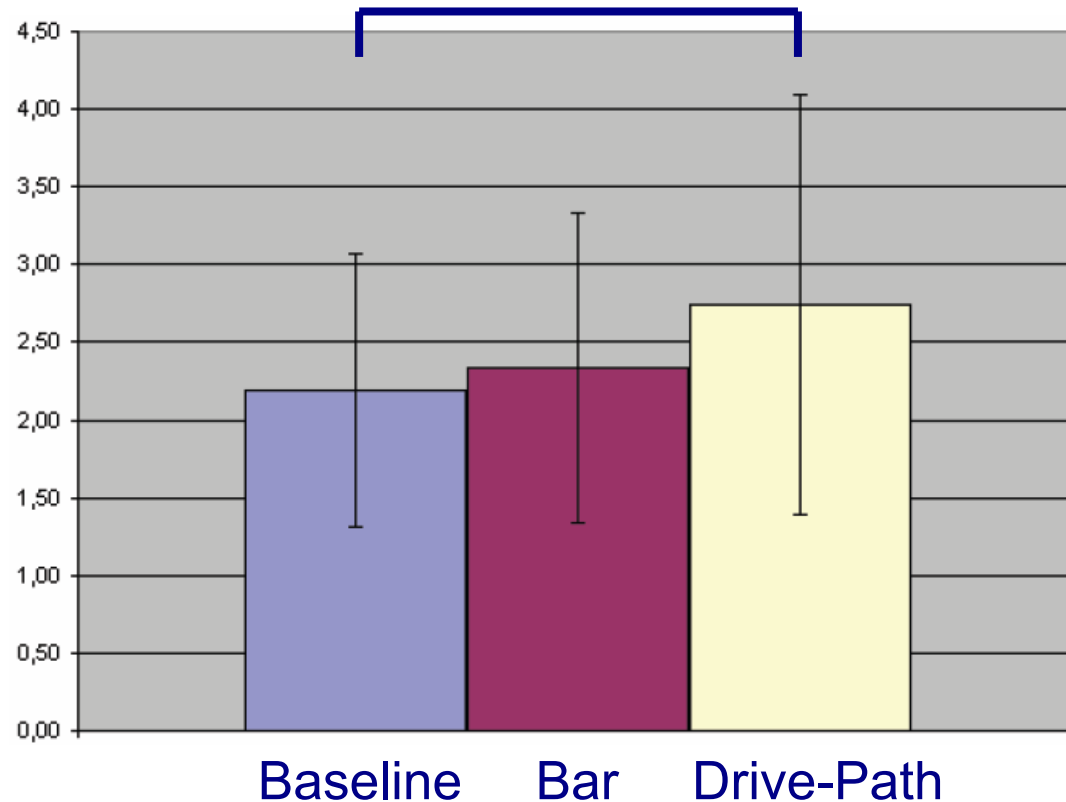
Subjective Measurements: Overall Driving Quality

German school grade system, ranging from 1 (best) to 6 (worst)



Subjective Measurements: Concentration on Task of Driving

German school grade system, ranging from 1 (best) to 6 (worst)



Discussion

- Visual assistance raises feeling of safety
- Drivers seem to neglect obligation to maintain proper speeds the higher the visual assistance
- Lane deviation decreases the higher the visual assistance
- Test subjects judge an improved overall driving quality for the bar scheme
- Visual assistance does not increase overall workload
- Common design principles for visual aids in time-critical systems: minimal and easy to perceive

=> Bar scheme promising for further analysis

Conclusion & Future Work

- Two visual presentation schemes for concurrent feedback of driving physics
 - Bar scheme – Braking distance, lateral information
 - Drive-Path scheme – enhanced lateral information
- User study revealed promising benefits of bar scheme for further analysis:
 - Test on effects of tunnel vision
 - Platooning aid – Indication of following distance
 - Incorporate into real car – currently building life-size conformal HUD

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