

**Driver situation awareness
in traffic situations of varying complexity:
Requirements for intelligent driver support**

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Advanced Driver Assistance Systems, Situation Awareness and Road Safety

*From HUMANIST TF F draft report on ITS and driving task models –
General analysis of ADAS potentials*

ADAS can increase situation awareness: Help with the interpretation of the situation, the prediction of the behaviour of other road users and the anticipation of the effect of one's own actions.

- **ADAS in question: Integrated navigation and driver warning system providing also information about atypical road features relevant for road safety.**

Situation awareness

Definition (Endsley, 1988): The perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future.

Three levels:

- **Level 1: Perceptions of the elements in the environment**
- **Level 2: Comprehension of current situation**
- **Level 3: Projection of future status**

Situation awareness in traffic

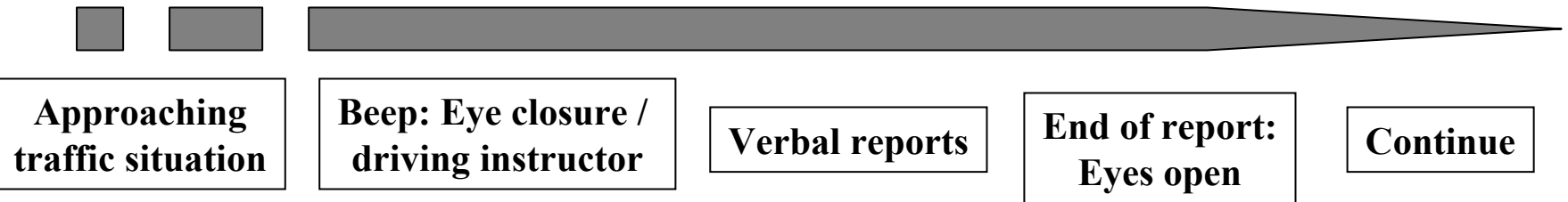
- **Experienced drivers: Information search is knowledge driven and based on expectancies (i. e. top-down control; Summala and Räsänen, 2000)**
 - e. g. **zebra crossing**:
 - ~ **road sign: activation of mental model**
 - ~ **procedural rule: if pedestrian wants to cross, then stop at zebra**
 - ~ **consequence: visual search for pedestrians**
 - ~ **search result: pedestrian (yes/no)**
 - ~ **decision: stop before zebra (yes/no)**
- **Internal mental models affect the subjective significance of incoming information (Endsley, 2000)**
- **Intelligent driver support requires consideration of such qualitative aspects of traffic scenes**

Aim of the present study:

- **Examine perception of traffic elements (Situation Awareness Level 1) in realistic field study**
- **Examine influence of situation complexity on the quality of the driver's functional representation**
- **Identify driver information needs in unusual traffic situations**

Method, design & subjects

- **On road, field study. Within-subjects design, one factor: Type of traffic situation**
- **Three types of traffic situations: High, medium and low complexity**
- **20 Subjects: 10 male, Ø 27 years / 8.5 years license / estimated total kilometres 150 000**
- **‘Freeze-technique’ in the field: Eyes closed & driving instructor**
- **Open instruction: ‘Report all you can remember about the traffic situation before you closed your eyes’**
- **Retrospective verbal reports as data: Information in focal attention is verbalised**



- **Analysis of verbal reports: Statements (‘there was a...’ / ‘there was no...’) as indicators for visual search, irrespective of objective presence of search target**



The three experimental traffic situations: high, medium, low complexity
Common features: right-hand driving, two lanes, inner city, speed limit 50 km/h, right of way

Central hypotheses:

- **1 The drivers' visual search is focused on traffic elements relevant for the current driving task.**
More verbal reports including statements about other vehicles in the medium complex intersection situation;
more verbal reports including statements about pedestrians in the very complex zebra crossing situation.
- 2 The higher the complexity, the fewer resources are available for less relevant situation elements**
Fewer verbal reports including statements about less relevant elements in the more complex situations.



Category	<i>High compl.</i>	<i>Med. compl.</i>	<i>Low compl.</i>
Traffic [°]	11 (55%)	17 (85%)	12 (60%)
Pedestrians *	17 (85%)	5 (25%)	4 (20%)
Traffic Rules [^]	8 (40%)	8 (40%)	11 (55%)
Traffic Irrelevant [^]	7 (35%)	10 (50%)	13 (65%)

Chi-Square; * < 0.01, ° n.s (<0.1), ^ n.s

- **Top-down visual search: Zebra crossing – pedestrians (intersection – traffic)**
- **Fewer resources with increasing complexity: Not confirmed**



Two additional comparisons:

Reports including 'intersection' element: High compl. 30% vs. medium compl. 65%
Chi square significant, $p < 0.05$

First and second zebra crossing reported in high complexity condition: 90% vs. 40%
Chi square significant, $p < 0.01$

Summary and discussion of main findings:

- **Visual search focused on elements relevant for current driving task:
Top-down control of perception of situation elements (situation awareness level 1)**
- **No significant effect of situation complexity on number of reports including less relevant situation elements: Effect of driving task demands on completeness of the drivers' functional representation of the situation could not be confirmed**
- **A share of drivers is not aware of the critical situation elements in the high complexity situation**

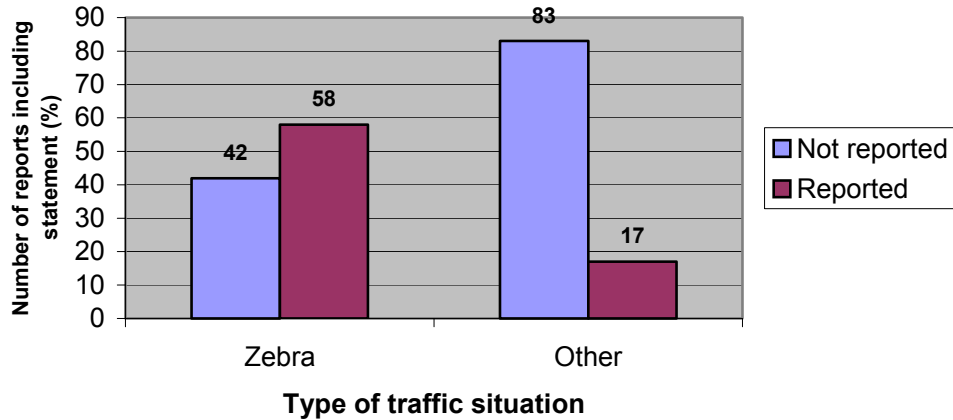
Conclusions

Introduction: *ADAS can increase situation awareness.*

- **Assist the driver by providing additional information when approaching an unusual traffic situation.**
- **The drivers situation awareness should be directed at any unexpected element that would not be a target of the drivers' top-down controlled visual search.**

**End of part 2:
Thanks again for your attention.**

Statements referring to absent pedestrians

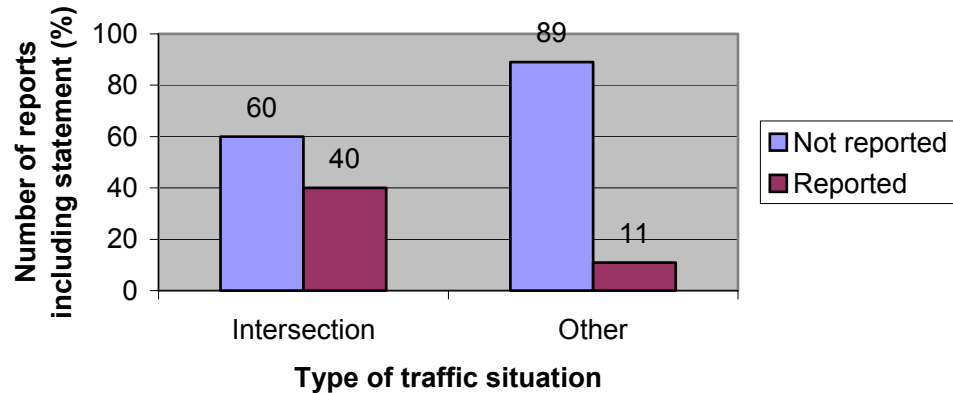


Absent pedestrians

[Zebra N=19 (8/11) / Other N=36 (30/6)]

Chisquare=9.899; df=1, p<0.01

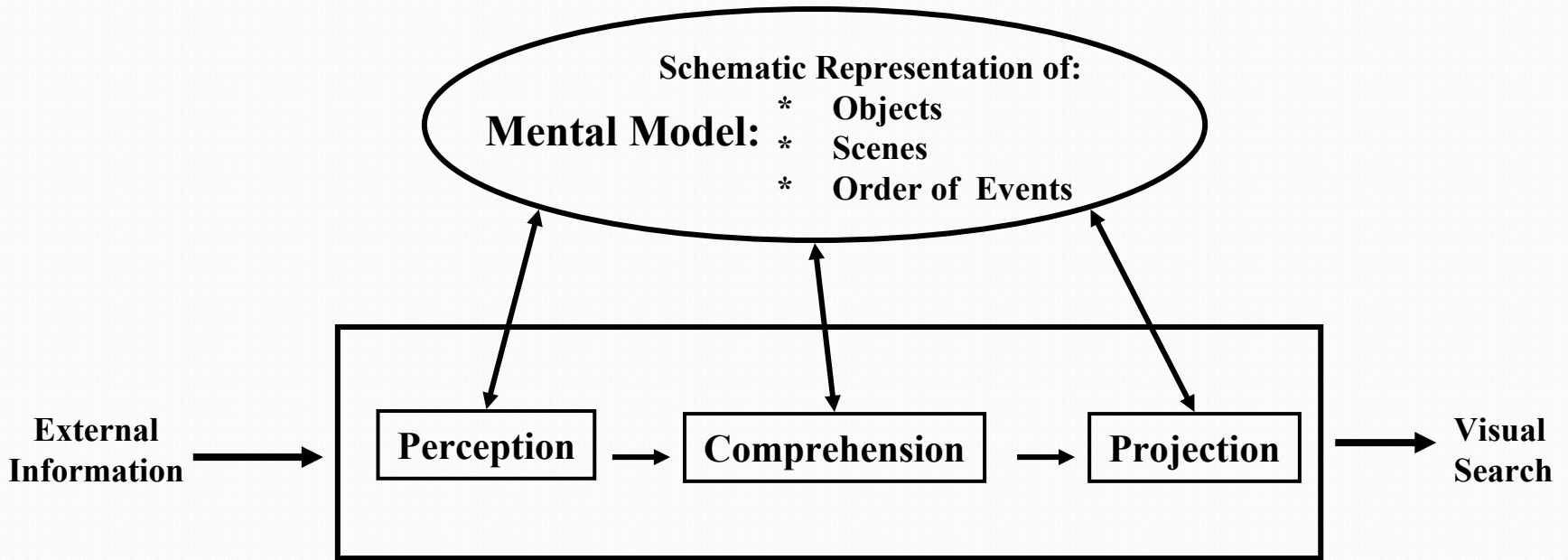
Statements referring to absent vehicles



Absent vehicles

[Intersection N=10 (4/6) / Other N=19 (17/2)]

Fisher-Yates (small exp. frequencies) p=0.086



Simplified relation between Mental Models and Situation Awareness (after Endsley, 2000 / Mogford, 1997)

Fastenmeyer (1995) Classification of traffic situations

- 1 High demands on info processing and car control:
Monitor environment to produce a driving decision (*zebra: pedestrians, stop/go*)**
- 2 High demands on info processing and low demands on car control:
Info selection for evaluation of potential dangers (*priority intersection*)**
- 3 Low demands on info processing and car control:
Basic perceptual input to keep car on the road (*free and straight road sections*)**