Context Information Captures Acceptability of Alerts to Pedestrians

AstaZero Researchers Day –
"Emerging Trends in Active Safety for Road Vehicles"

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Jan-Erik Källhammer
Autoliv Research, Vårgårda Sweden
Kip Smith
Naval Postgraduate School, Monterrey, CA, U.S.A

When to issue an alert

- Should the system issue an alert for this pedestrian?
- What about this one?

Should an alert be issued here?

- No alert should be issued when the pedestrian is sufficiently
  - far away or to the side
- Is this such a situation?

- Is this?

- Where is the transition zone between alerts and no alerts?

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Challenge: Define an adequate activation criterion

- Always before a collision
- Never when the risk of a collision is sufficiently low
  - the driver may not respond to subsequent, justified alerts (“cry wolf”)
- Situations that lie in-between hold the key to driver acceptance
  - Most alerts will be issued in in-between situations.

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Analyzing Driver acceptance of pedestrian alerts

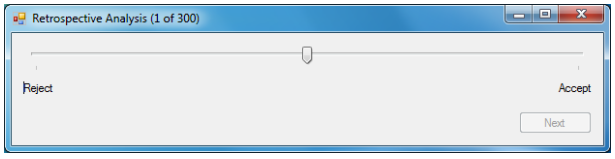
1) Field Operational Test
   - Data collection
   - Filter out pedestrian encounters

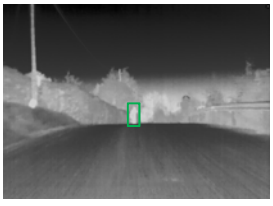
2) Retrospective analysis
   - Driver ratings

3) Analysis
   - Regression model

Retrospective analysis used in this study

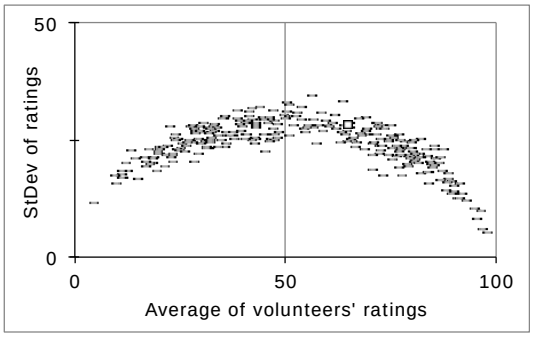
- Volunteers watched and rated a video sequence of recorded events.
  - They judged whether the situation warrants a warning
  - Clear instructions for scale use:
    - Treat as interval data -> justify parametric statistical analysis





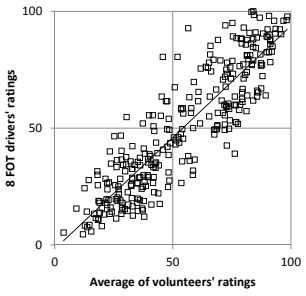
  - 150 clips rated by one group of 37 volunteers
  - Another 150 clips rated by a second group of 37 volunteers

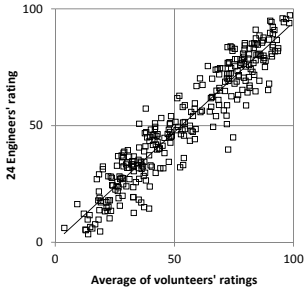
High agreement for clear alerts & no alerts. More variation in the transition zone



Drivers and lab subjects rate events consistently

- Ratings by drivers with system experience align with the ratings of volunteers without system experience.





Each group of participants rated events consistently

- The ratings are highly consistent across individuals within groups.
- Kendall's W:
  - W= 0.56, $\chi^2(296) = 3491$, $p < .0001$ for the 42 Swedish drivers without system experience
  - W= 0.72, $\chi^2(296) = 849$, $p < .0001$ for the 8 Swedish drivers in the FOT
  - W= 0.62, $\chi^2(296) = 2210$, $p < .0001$ for the 24 Swedish Engineers
  - W= 0.57, $\chi^2(296) = 6252$, $p < .0001$ for all 74 Swedish raters
- The consistency supports using the mean ratings in model development.

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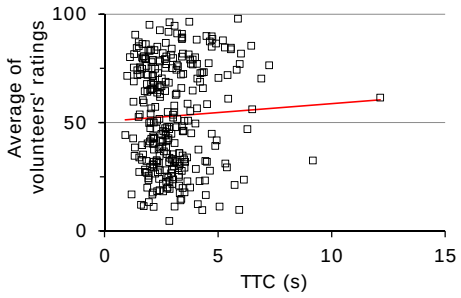
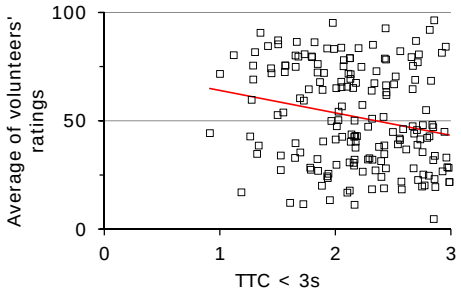
Time to Collision (TTC) not a good predictor

- No overall effect



- Slight effect for low TTC
  - But r^2 is only .05



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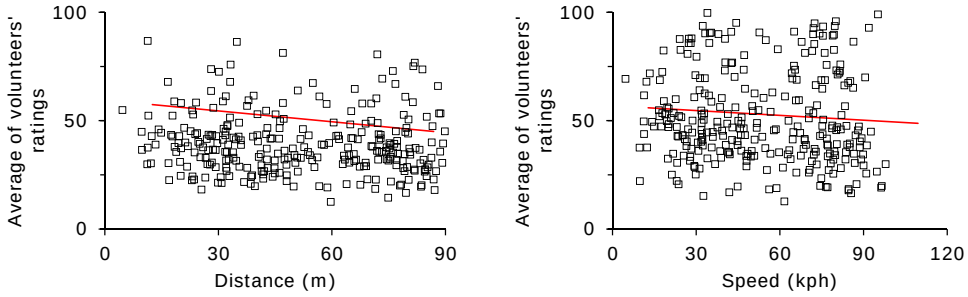
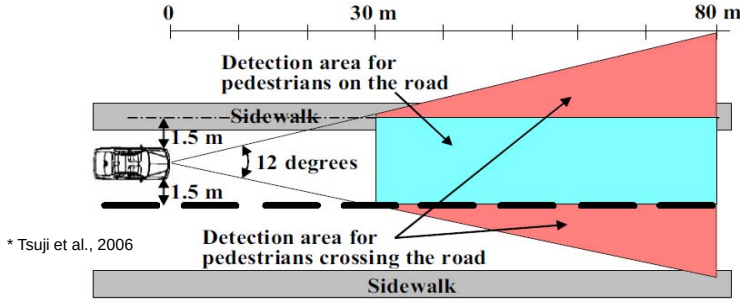
Neither distance nor vehicle speed are good predictors

- No overall effect of either distance or vehicle speed



Honda's published alerting criteria

- The warning beeps occur when the vehicle would reach the pedestrian's location in approx. 4 sec (TTC~4 s)*
  - Honda obviously don't use TTC as an alert predictor



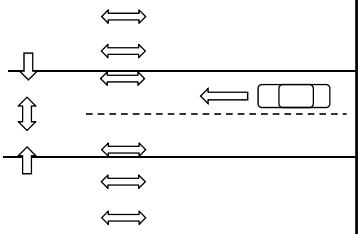
* Tsuji et al., 2006

- Honda consider pedestrian location and motion relative to the road

Annotate pedestrian location and motion

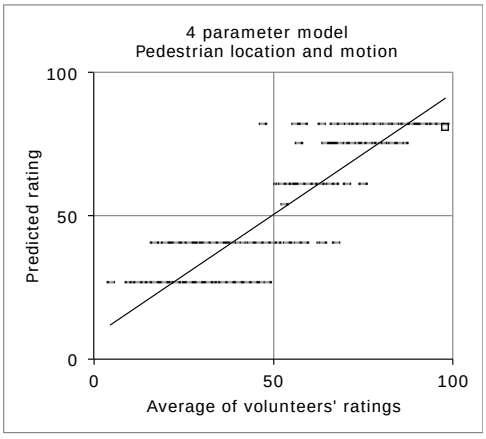
- ANOVA analysis of categories
- Consolidate factors without significant differences

Pedestrian location	Pedestrian motion	Consolidated factors
In Road Right edge Left edge	Into or Out of Road Into road Into road	In or into road
Right edge	Same, Opposite or Standing	Right edge
Left edge Right side	Same, Opposite or Standing Same, Opposite or Standing	Left edge or right side
Left side Far right side Far left side	Same, Opposite or Standing Same, Opposite or Standing Same, Opposite or Standing	Left side or far side

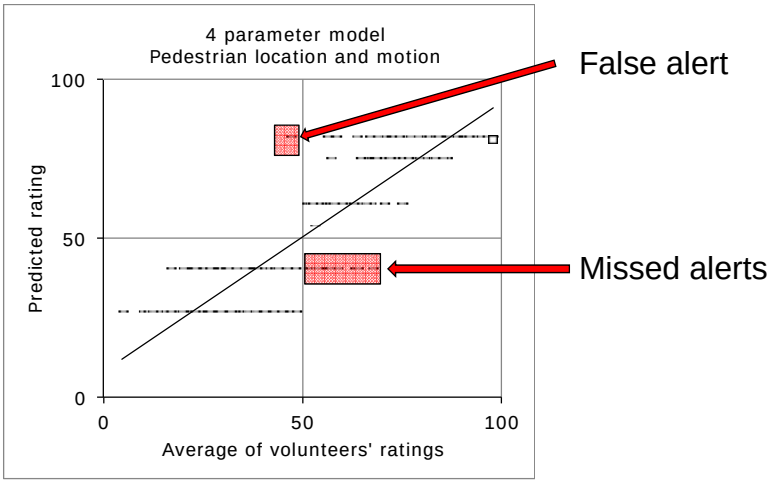


Modelling results

- Regression modelling using only categorical parameters
- Adjusted r^2=0.85
  - Very high agreement when dealing with human decision making



Improving the model



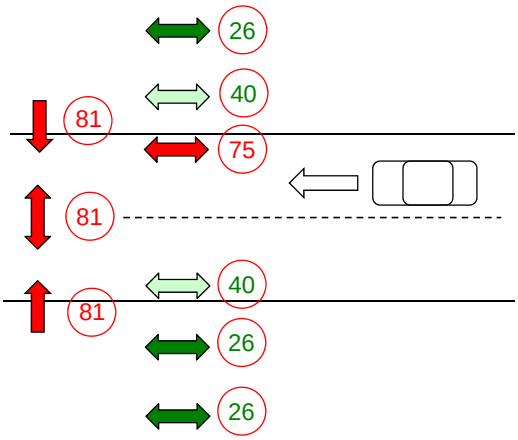
Testing additional contextual factors

Models	SSE	Lack of fit test F*	p(F*)
4 factor model (df = 295)	24946		
5 factor models (df = 294)			
+ Other vehicles	24735	2.509	0.114
+ At bus stop	24760	2.208	0.138
+ Suburban	24773	2.048	0.153
+ More than 1 pedestrian	24821	1.477	0.225
+ More than 2 Lanes	24885	0.720	0.397
+ Turns prior to detection	24902	0.522	0.470
+ Behind hill crest	24936	0.108	0.743
+ In/near pedestrian crossing	24944	0.020	0.889

- None of the additional predictors improved the 4 factor model

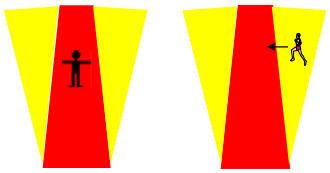
Best-fit linear model, 4 predictors. $r_{adj}^2 = 0.853$

Rating = 60
+ 21 * In or Into Street from Right or Left
+ 14 * Parallel or Standing on Right Edge of Street
- 21 * Parallel or Standing on Left Edge of Street or Right Side near Street
- 35 * Parallel or Standing on Left Side near Street or Any Side away from Street

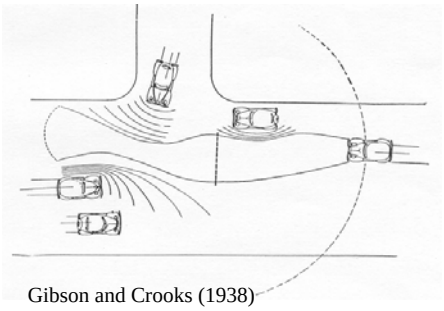


The concept "Field of Safe Travel" may explain contextual dependencies

- Pedestrians can be seen to infringe in the 'field of safe travel' when they are either:
  - in the street or
  - moving towards the street



- These intuitive results add credibility to the method.



Gibson and Crooks (1938)

Conclusion

- Subjective ratings are consistent within and across groups of participants.
- Ratings are the foundation of a sound model of driver acceptance of pedestrian alerts with high driver acceptance.
- The results suggest that the perceptual cues that drivers use to rate in-vehicle alerts may largely consist of basic contextual factors.
- The study also shows how to leverage expensive FOT data effectively in a controlled laboratory study.

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