Inattention-Risk Function
(for Lead Vehicle Crashes)
- A SHRP2 S08 Analysis Project

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Inattention-Risk Function – Lead Vehicle
Research Question

• “How does driver inattention, as observed through measures of single glance (inopportune glance, single long glance) and glance history (intensity, duration), influence the risk of crash severity in Lead Vehicle Stopped, Lead Vehicle Decelerating, and Lead Vehicle Moving at Lower Constant Speed pre-crash scenarios?”

➢ Will develop a statistically validated inattention-risk function
Sub-questions to RQ1

• RQ1.1: Which algorithm or combination of measures of single glance (inopportune glance, single long glance) and glance history (intensity, duration) is most relevant for present analyses?

• RQ1.2: What crash severity scale is best suited for analysis of risk?

• RQ1.3: How does the timing of stimuli onset (e.g. lead vehicle braking onset) in relation to an off-road glance influence evasive maneuver quality (smooth, abrupt, or no maneuver) and crash likelihood?

• RQ1.4: How do the results of this research translate into countermeasures?
# SAFER Team

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<tr>
<th>Names</th>
<th>Role in Study</th>
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<td>Severity scale</td>
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Administrative Officer: Ines Heinig (Helena Gellerman)
Methodology

Interaction with SHRP2 Database

T1-4-1: Form Event Dataset
- Identify typical context for the pre-crash scenarios
- Identify a pool of candidate events from within the crash relevant portions of the driving data
- Perform severity classification within the pool of relevant candidate events
- Enrich dataset by annotating contextual event attributes

Interaction with Event Dataset

T1-4-2: Calculate Performance Indicators
- Data quality analysis
- Data Processing
- Performance Indicator Calculation (from time series to aggregated data)

T1-4-3: Calculate Statistics
- Extreme Value
- Multivariate
- Descriptive

T1-4-4: Interpret for Countermeasures
- Vehicle and Technology Countermeasures
- Societal Countermeasures
Problem: Categorical approach

(Dingus et al., 2006)
1) Risk

**Solution:** Continuous event severity measure

Severity = \[ f(\text{safety margin, injury risk}) \] (Svensson, 1998) (Najm and Smith, 2004)
(1) Continuous event severity

- A continuous scale of event severity will enable more powerful statistics.

Combination of Safety Margin and Injury Risk:

- **Safety Margin**
  - **Method 1:** Time-to-Accident (TTA) is estimated at the onset of braking and equals the Time-to-Collision, TTC, value at the specific moment (Svensson, 1998)
  - **Method 2:** A complementary method uses the rate of which the current distance between the road users are being decreased and then, by determining the distance divided by range rate, calculate the time until the distance is zero is determined (Najm and Smith, 2004).

- **Injury Risk**
  - Delta-V (the calculated difference in velocity before and after the crash) for each of involved road user at the time of conflict, i.e the moment the evasive action is initiated (e.g. Worst Case Delta-V)

\[
\text{Event Severity} = \text{TA} \times \Delta V_1 = \text{TA} \times \frac{m_2(V_1 - V_2)}{m_1 + m_2}
\]

where TA is Time-to-Accident, V1 is the initial speed of road user 1, V2 is the initial speed of road user 2, and m1 and m2 are the corresponding weights of the involved road users.
(2) Inattention

Feasibility of:
Automatic visual behavior analysis
vs
Video-based glance reduction
(2) Inattention

Single Glance
- Single Long Glance
- Inopportune Glance

Glance History
- Intensity
- Duration

(Zwahlen, 1988)
(3) Timing

- Classic lead vehicle crash (100-car videos)!

- Timing of off-road glance patterns in relation to bottom-up (stimulus-driven) attention capture cues:
  - Stimuli onset variables (e.g. brake light onset, sudden lead vehicle lane change)
(3) Timing

Sneak preview! Analysis of 100-car data (Victor and Dozza, 2011)
Vehicle and Technology Countermeasures

Safe Technology Design
Improved performance scales and criteria for guidelines, standards, checklists, especially the establishment of performance-based standards which set out the minimum level of performance (e.g. eye glances) that a system must meet when tested in accordance with a prescribed test method.

Active Prevention of Inattention Occurring While Driving
Improved context-awareness and inattention-detection algorithms to prevent distraction and inattention from occurring in the first place, e.g. by information scheduling, demand-based advisories, function lock-out, adaptation of information format, etc.

Inattention Mitigation While Driving
to driving when judged as being “too distracted” according to predetermined criteria set by the system, the driver, or the owner (e.g. Visual distraction alert, Cognitive distraction alert, on-line drive recorder feedback).

Inattention-Adaptive Collision Warning Functions
the timing, intensity, duration, complexity and/or modality of warnings (e.g. Forward Collision Warning).

Off-vehicle Monitoring and Post-trip feedback
performance feedback metrics (in "report cards", in-person coaching with video), Behavior-Based Safety programs, etc.
Societal Countermeasures

Policy, Legislation and Enforcement
inattention performance criteria to be set for technology or comparisons to be made between technology.

Distraction-Tolerant Road System Design
The results will indicate priorities for changes to road system design, such as occlusions at intersections, intersection signalling, etc

Education, Outreach, Training, and Licensing
licensing.

Distraction Evaluation, Ratings, and Certification Programs
Improved performance-based standards can be implemented as part of programs for evaluation, rating and certification of technology and vehicles