Behavioural adaptation to adaptive front lighting systems: An exploratory six day driving simulator study

NB! The SINTEF results presented here are one part of several studies.
Objective – SINTEF studies

• Evaluation of adaptive lights with regard to
  ✓ Safety
  ✓ Behavioral Adaptation
Safety needs

• In Europe 55% of driving fatalities occur at night
  ✓ 25% of driving takes place at this period.
  ✓ 40% of pedestrian fatalities occur at dawn.

• In response to the concerns,
  ✓ The headlamp system in personal vehicles may be improved to accommodate different traffic situations during night time driving.
  ✓ The lighting system should adapt to various road conditions and geometries as well as different ambient conditions.
Behavioral adaptation

- Main Challenge
  - ✓ Assessing behaviour as it finds some kind of basic stability.
  - ✓ Estimates of the safety impact of new in-vehicle systems should not ignore behavioural adaptation.
  - ✓ System designers must assume that behavioural adaptation will occur, and the nature of these changes should be identified in case they are unsafe.
Adaptive lighting system description

- AFS Respond to various situations of vehicle and environmental parameters such as
  - Speed, weather and traffic road conditions,
- Various beam patterns are produced to provide
  - Better visibility to the car or truck driver
  - Less glare
- Future systems may use input from satellite positioning, (GPS/Galileo) inertial sensors and digital maps
Adaptive lighting system description

- **Town Light**
  - Cornering system in City scenario: the driver receives additional light in the corners when driving at slow speed.
  - Symmetrical beam pattern with reduced glare light for slow driving situations and a defined amount of ambient illumination

- **Country Road Light**:
  - Bending system in Rural scenario: the lights will “follow” the curves according to how the drivers move the steering wheel.
  - Asymmetric beam pattern similar to today’s low beam.
SINTEF Driving research simulator

A combined car and truck simulator
Scenarios

- City
Events - 12 in city scenario

With AFS; Without AFS; In daylight

To the LEFT

To the RIGHT
Scenarios

- Rural
## Method

### Procedure

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<td>93km AFS</td>
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<td>43km Non-AFS</td>
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<td>final questionnaire, comparison of systems</td>
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### Design

**Day 1**: Within subjects. 22 participants.
Balanced order with regard to:
1. system in city/rural
2. system/baseline

**Day 2**: 16 participants. Same design as day 1

**Day 3-5**: 16 participants. Training.
1. 8 Drive only AFS city/rural/motorway
2. 8 Drive only non-AFS city/rural/motorway

**Day 6**: 16 participants. Same design as day 1
Metrics

- Mean Speed – throughout drive
- Mean Speed – in curved sections (rural)
- Mean Speed – in corners (city)
- High frequency steering – throughout drive and in sections (see above)
- High frequency steering reversals – only in sections (see above)
- Mean lateral distance to obstacle – only in sections (see above)
Speed development day 1 - 6

We would presume that AFS should increase mean speed.
Results shows that speed is significantly reduced with AFS in City.
**Speed profile Day 2 and 6**

- The observed lateral distance for the AFS and Non-AFS systems did not differ \((p>0.1)\). Neither within sequence or between sequence 2 and 3.
Braking

- Brakes applied more effectively with AFS
Steering Frequency / Reversals and Lane Position

- No significant effects in City or in Rural scenarios
- Neither day 1 nor day 6
Conclusions (1)

The results suggest:

- There is a behavioural adaptation to AFS in terms of speed choice with increase in speed after the initial familiarization, but not for the other selected indicators of behavioural adaptation.

- The speed increase for Non-AFS is consistently and significantly higher than for AFS in the City scenario.

- Drivers with AFS technology did change their driving pattern, but only in terms of driving speed. Lateral distance to obstacles and steering wheel measures did not change.

- AFS in comparison to standard headlights appears to offers favourable night driving behaviour and potentially reducing accident risk.
Future studies

• Within the 6 day time frame of the experiment
  ✓ Night driving, speed level appears to be stable for passing potential traffic hazards in city environments and stable already after the initial day in terms of general speed level in Rural environments.

• Future studies should strive to test
  ✓ To what extent the developmental pattern here found after a six-day exposure is representative for the ‘essence’ of AFS driver behaviour –
  ✓ Both in terms of selected indicators and in terms of length of exposure.
Thank you for your attention!

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