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# Learner Drivers' Control of Dual Mode Vehicles

Arie P. van den Beukel (presenter) Nina Veders, Cornelie J.G. van Driel, Chris Huijboom



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## Changing, but **demanding** drivers' role

- Increase Driver Assistance & Automation
- Drivers responsible for safe operation

"ADAS can potentially have a positive influence on road safety, but as yet there are no guarantees that that potential will be truly fully utilized."

(Dutch Safety Board, 2019)



### Safer cars for safer roads: Council agrees to tougher rules on vehicle safety

The EU is introducing legislation which will require various safety features to be included on a range of vehicles with the aim of saving lives on Europe's roads. The Council today agreed its position on the new rules which means that negotiations can begin with the European Parliament as soon as it has adopted its position.

- We must never let up in our efforts to make our roads safer for everyone. These new rules, which reflect the latest technical developments, will protect and help save lives.
  - Norbert Hofer, Austrian Federal Minister for Transport, Infrastructure and Technology

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Under the proposed regulation, vans and Sport Utility Vehicles (SUVs) will no longer be exempt from various safety features which until now have only been required for ordinary passenger cars. These features include tyre pressure monitoring, intelligent speed assistance, alcohol interlock, driver drowsiness monitoring and emergency stop signals.

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## Changing, but **demanding** drivers' role

- Increase Driver Assistance & Automation
- Drivers responsible for safe operation
- Vigilance & behavioural adaptation
- Slower reaction times, misinterpretation
- Reduced situational awareness
- Skill degradation
- > Intervention: Peaks of workload (stress)

Gap between drivers' responsibilities and human capabilities for safe vehicle operation





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## Changing driver's role and driving license

• New role not included in licensing

How to assess a learner driver's role as supervisor and responsible operator of system-controlled vehicle functions?



Prautocol project; License B; country NL



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## Assessment of supervision and acquiring driving skills

- Current (Dutch) practice: Subjective appraisal safely participate in traffic
- Learning process (Bloom)
- Dutch handbook for driving instructors
- Michon's model of driving task
- Rasmussen's performance levels

Assessment aspects										
	Failed	Preparation to take part in traffic; operating vehicle	Environment- consciously driving	Adaptation to circumstances and decisive driving	Interests of other road users	Viewing behaviour	Giving priority	Road position and place of manoeuvres	Keeping distance	
Driving off										
Driving on straight and curved road sections										
Behaviour when approaching and crossing an intersection										
Merging into traffic / merging out										
Taking over other traffic and lateral movements										
Behaviour when approaching and passing special road sections										
Special manoeuvres										

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## Towards assessment of **supervisory role**

### Step 1: Narrative review by authors

- Collect required (behavioural) skills
- Compare **relevance** between manually driving and operated by system
- What aspects are key to assess the changed driver's role, need extra attention for appraisal of drivers' supervisory role

#### Sources:

- Licensing authority (CBR, 2013): recommended driving method for driving instructors
- book 'Mobility and behaviour' (CROW, 2014)
- Training material instructors
- Interviews with instructors
- Papers driving skills

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 Papers on drivers' interaction with assistance systems

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## Towards assessment of **supervisory role**

### Step 1: Narrative review by authors

- Collect required (behavioural) skills
- Compare **relevance** between manually driving and operated by system
- What aspects are key to assess the changed driver's role, need extra attention for appraisal of drivers' supervisory role
- Step 2: **Expert appraisal** (by instructors and examiners)



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## Assessment aspects of drivers' supervisory role

- Performance on tactical level: system control in relation to traffic circumstances. Remaining driver's tasks generally changes to tactical level (note: danger confusion)
- System-understanding (system mode, system capabilities, boundary conditions) Especially important during special manoeuvres and adverse weather conditions
- Adequate perception of relevant road-traffic situations. Hampered assessment of scanning patterns due to latent need for road scanning.
- Adequate anticipation and correct projection how traffic develops. Hampered assessment while cues in manual control 'covered' by system's actions
- Accounting for the interests of other traffic participants. Systems has no contextual knowledge and understanding of cues other road users.
- > Does the learner driver remain in control of the assistance function?



## **D-Brief**

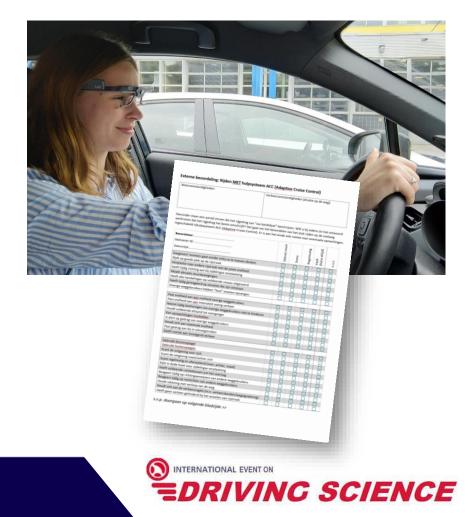
- <u>D</u>river <u>B</u>ehaviour <u>R</u>ating <u>I</u>nventory and <u>E</u>valuation <u>F</u>orm
- 29 generic assessment aspects (independent of ADAS-type)
- Observation of assessment aspects, scored with
  - (Almost) never; Occasionally; Often; (Practically) always
  - \*Not applicable\*
- Allows self-assessment & expert evaluation
- 9 specific propositions on ACC understanding

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## **Road study**

- 12 participants, max. age of 27 years
- Toyota C-HR with ACC
  - Mobileye (speed & distance)
  - Eye-tracking
  - Camera observation road view & interior
  - Laptop for annotation of lane changes
- 2 sessions of ca. 45 min. driving
  - Manual vs. with ACC
  - A50 highway section Arnhem <> Zwolle
- Appraisal driving task (D-Brief)
- Vehicle data



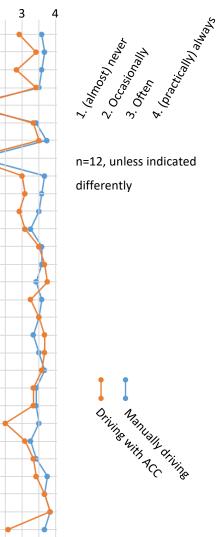
- Consistent decline in driving performance with ACC
- Small differences

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#### Average scores driving performance (D-Brief)

Smooth operation of brake and acceleration pedals Good position on lane Lane changes with appropriate speed Timely operation of indicators when changing lane Abrupt control of steering wheel All manoevres conducted at sufficient level Timely reaction on situations that occur (n=11) Mistake required other road users to counteract (n=7) Speed aligned with speed of other road users Speed aligned to traffic intensity Timely decision making to avoid hindrance to road users Appropriate distance to vehicle in front Apropriate judgement how traffic progresses Attentive to behaviour of other road users Adheres to speed limits Adapts behaviour at on and off ramps (merging traffic) Provides space to merging traffic Uses interior mirror Uses outside mirrors Appropriate scanning of front view Appropriate scanning of side views Regular and alternating scanning (front, rear, sides) Checks blind spot before changing lateral position Sufficient spatial cushion around the vehicle. Timely reaction on indicators of other road users Timely reaction on brake lights of other road users Appropriate judgement how road layout progresses Adheres to traffic rules

No hinder to traffic participants when changing lanes



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Smooth operation of brake and acceleration pedals Good position on lane Lane changes with appropriate speed Timely operation of indicators when changing lane

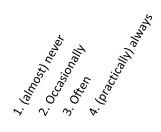
#### Abrupt control of steering wheel

All manoevres conducted at sufficient level

#### Timely reaction on cituations that occur (n=11) Mistake required other users to counteract (n=7) Speed aligned with speed of other road users

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No hinder to traffic participants when changing lanes



n=12, unless indicated differently



- Consistent **decline** in driving performance with ACC
- Small differences
- ACC somewhat positive influence on
  - Space for merging in traffic
  - Using mirrors

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### Adheres to speed limit

Adapts behaviour at on and off ramps (merging traffic) Provides space to merging traffic

#### Uses interior and outside mirrors

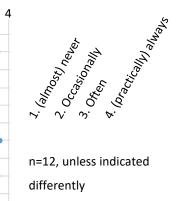
Appropriate scanning of front view Appropriate scanning of side views

Regular and alternating scanning (front, rear, sides)

#### Checks blind spot before changing lateral position

Sufficient spatial cushion around the vehicle. Timely reaction on indicators of other road users Timely reaction on brake lights of other road users Appropriate judgement how road layout progresses Adheres to traffic rules

No hinder to traffic participants when changing lanes





- Consistent **decline** in driving performance with ACC
- Small differences
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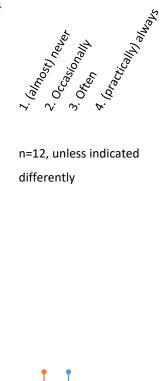
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• Hinder to road user with self-initiated lane changes

#### Average scores driving performance (D-Brief)

Smooth operation of brake and acceleration pedals Good position on lane Lane changes with appropriate speed Timely operation of indicators when changing lane Abrupt control of steering wheel All manoevres conducted at sufficient level Timely reaction on situations that occur (n=11) Mistake required other road users to counteract (n=7) Speed aligned with speed of other road users Speed aligned to traffic intensity Timely decision making to avoid hindrance to road users Appropriate distance to vehicle in front Apropriate judgement how traffic progresses Attentive to behaviour of other road users Adheres to speed limits Adapts behaviour at on and off ramps (merging traffic) Provides space to merging traffic Uses interior mirror Uses outside mirrors Appropriate scanning of front view Appropriate scanning of side views Regular and alternating scanning (front, rear, sides) Checks blind spot before changing lateral position Sufficient spatial cushion around the vehicle. Timely reaction on indicators of other road users Timely reaction on brake lights of other road users Appropriate judgement how road layout progresses

#### No hinder to other traffic when changing lanes





## Results (2) self-evaluation vs. expert-assessment

- 54% (53%) conformity in scores between self-evaluation and expert (manually driving / with ACC)
- Driving Assistant (with or without ACC) has no influence on self evaluation Distribution in scores between self-evaluation and expert:

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- Conformity at higher range of performance
- Disagreement at lower range of performance
  - When performance is low drivers assess themselves more positively in line with other studies
- 31% of participants report themselves that **behaviour changes** due to the assistant system

## Results (3) Lane changes

- Significant less lane changes with ACC
  - Demandingness of lane changes due to OOTL
  - Or: less need for lane changes

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Number of Lane Changes per trial						
	Mean	SD				
without ACC	29,08	9,52				
with ACC	19,17	5,37				

## **Results (4)** System understanding

- "Understanding" and "ability to drive with ACC" 100% expert consent
- However low consent on "is in control" (17%).
- In 83% expert assessed the driver "to keep on lane longer due to ACC".



## **Conclusions (1)**

- We observe **specific changes in road behaviour** when driving semi-automatically
  - Even on "Low-level", i.e. ACC
- Small but systematic reduction of driving performance
- Relevant changes for **driving proficiency** and assessment
  - Remaining human tasks transgress higher levels, i.e. tactical and strategic
  - Additional driving task level "Supported by technology".
  - Does the learner driver remain in control of the assistant system?
- Our method **D-Brief is sensitive** to these changes and reveals them
  - Allows both self-evaluation and expert assessment
  - Comparison between expert and candidate, between manual and assisted driving

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• Good addition to current practice for assessment

## **Conclusions (2)**

- Clear policy needed
- Growing concern
  - EU mandatory systems
  - Dutch Safety Board

*"manufacturers must assess the risks of new innovations and be transparent"* 

*"rules are lagging behind in respect of (..) the training of users"* 

Advise to learn "from incidents and (..) actively including the experiences of users"

#### European Council Council of the European Union

#### Home > Press > Press releases

Council of the EU Press release 29/11/2018 11:25

### Safer cars for safer roads: Council agrees to tougher rules on vehicle safety

The EU is introducing legislation which will require various safety features to be included on a range of vehicles with the aim of saving lives on Europe's roads. The Council today agreed its position on the new rules which means that negotiations can begin with the European Parliament as soon as it has adopted its position.

We must never let up in our efforts to make our roads safer for everyone. These new rules, which reflect the latest technical developments, will protect and help save lives.

- Norbert Hofer, Austrian Federal Minister for Transport, Infrastructure and Technology

*lacking "determination (..) of how the risks can be mitigated"* 



#### ONDERZOEKSRAAD VOOR VEILIGHEID

#### Who is in control? Road safety and automation in road traffic



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## Recommendations

- Within subject **comparison** D-Brief **with vehicle data**
- Additional test(s)
  - More participants
  - Between expert consistency
  - Diversity of scenarios and road situations
  - Additional systems (LCA, ISA, etc.) and combinations
- Relate parameters to **assessment** of the **vehicle**.
- Quantifying acceptable performance levels

## Outlook

- Journal paper submission
  - Transportation Research
    Interdisciplinary Perspectives
- Your cooperation
  - Account for adaption (machine level and human)
  - Existing drivers
  - Training
  - Quantifying acceptable performance
  - etc



### Thank you for your attention

### Dr.ir. Arie Paul van den Beukel

For more information, suggestion and cooperation, please contact: +31 53 489 4853 a.p.vandenbeukel@utwente.nl