

Learner Drivers' Control of Dual Mode Vehicles

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December 10th 2019

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)



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



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

- Prautocol project; License B; country NL



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	Speed
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										

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
- Papers on drivers' interaction with assistance systems

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)



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

- Driver Behaviour Rating Inventory and Evaluation Form
- 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

Road study

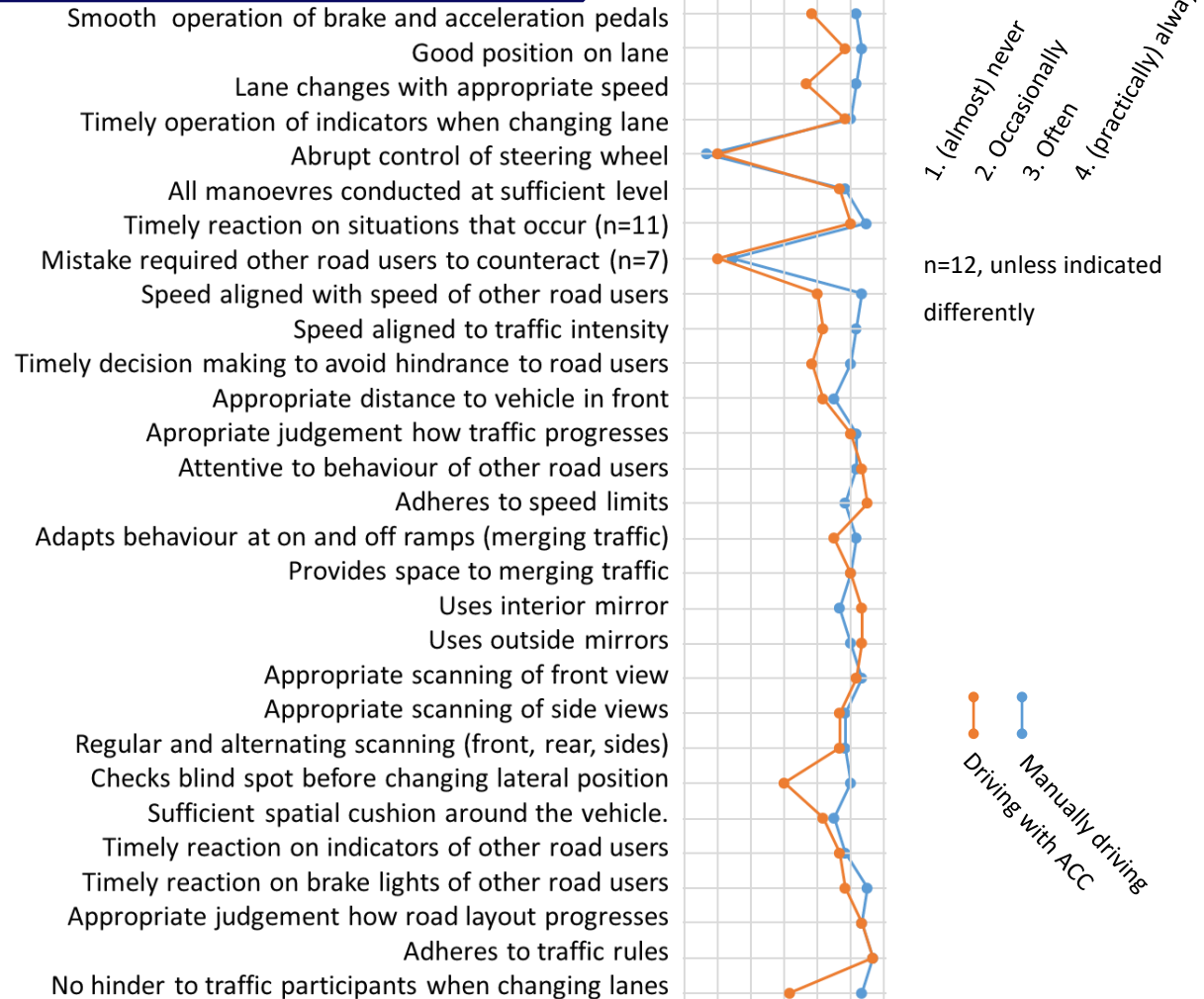
- 12 participants, max. age of 27 years
- Toyota C-HR with ACC
 - Mobileye (speed & distance)
 - Eye-tracking
 - Camera observation road view & interior
 - Laptop for annotation of lane changes
- 2 sessions of ca. 45 min. driving
 - Manual vs. with ACC
 - A50 highway section Arnhem <> Zwolle
- Appraisal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



Results (1)

- Consistent **decline** in driving performance with **ACC**
- Small differences

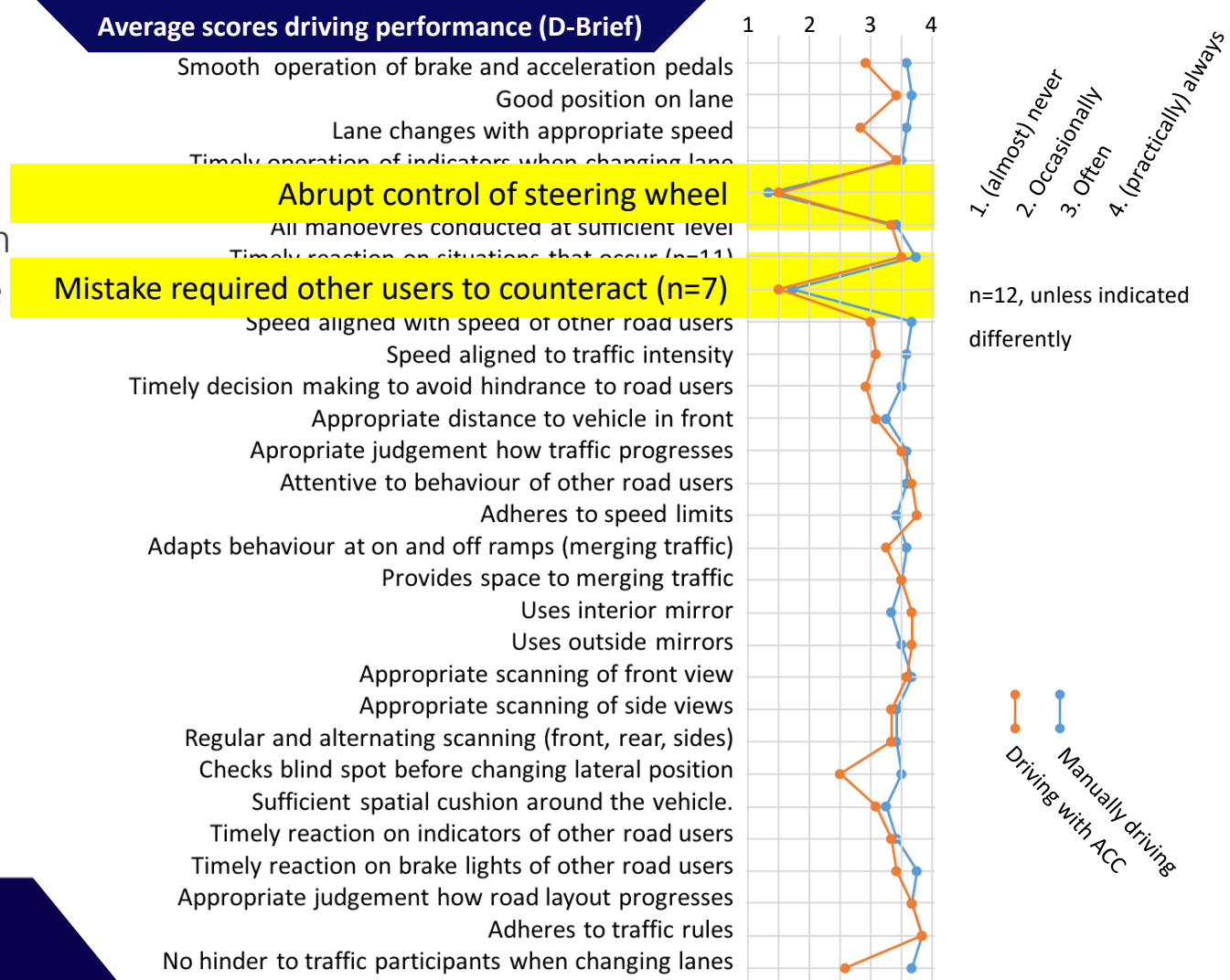
Average scores driving performance (D-Brief)



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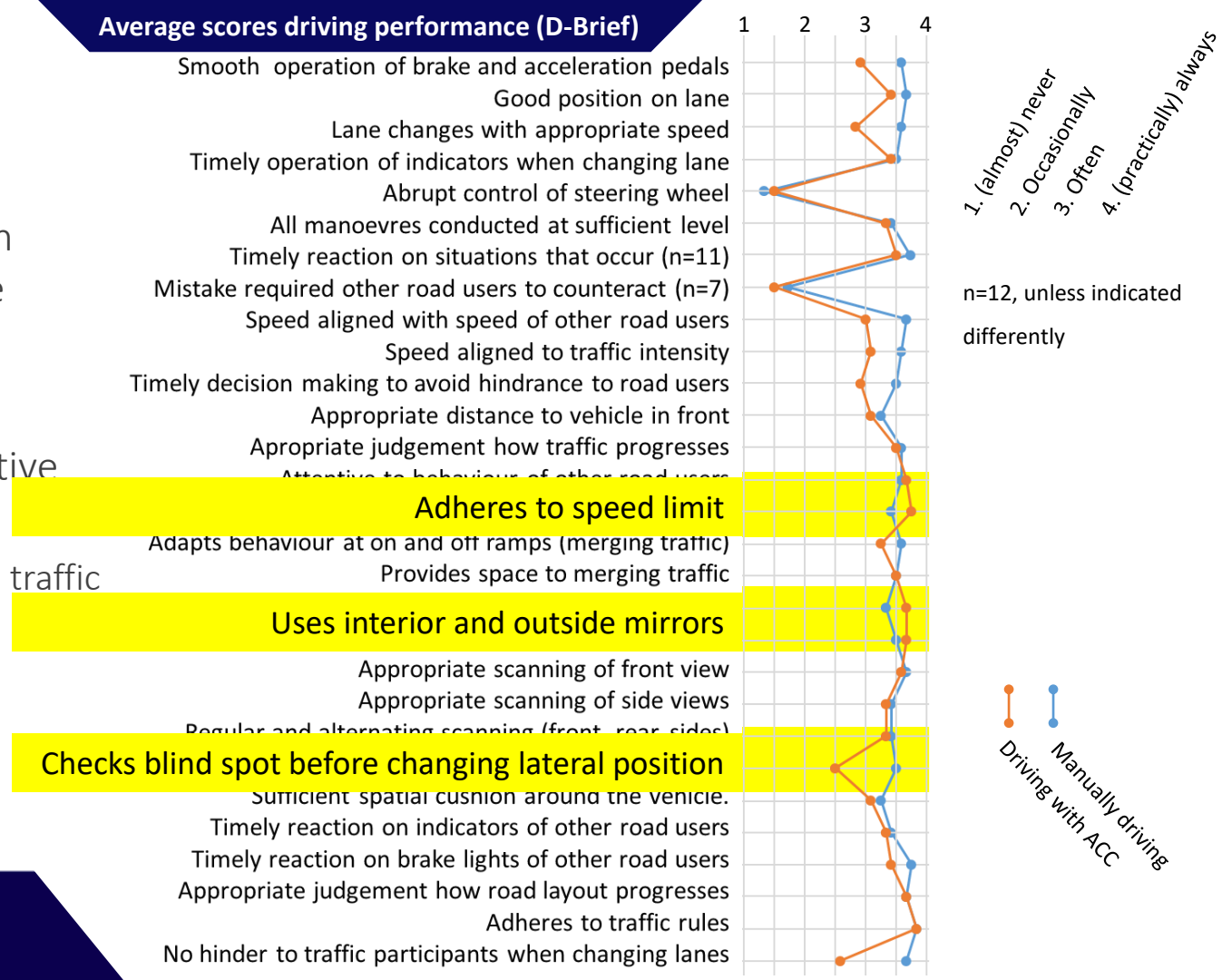
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Results (1)

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

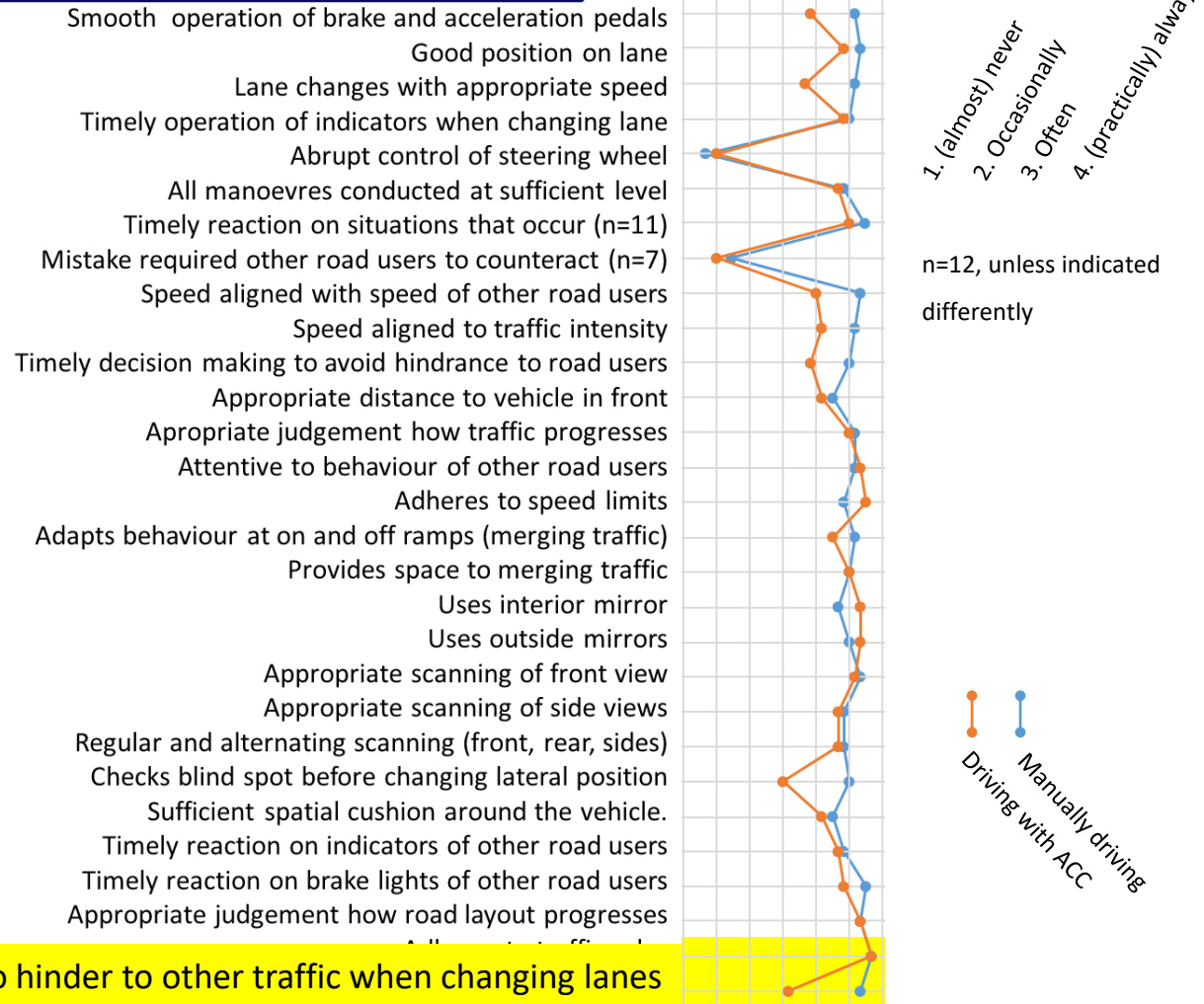
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Results (1)

- Consistent **decline** in driving performance **with ACC**
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- ACC somewhat positive influence on
 - Space for merging in traffic
 - Using mirrors
- Hinder to road user with self-initiated lane changes

Average scores driving performance (D-Brief)



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:

- 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

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**
- 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”



lacking “determination (..) of how the risks can be mitigated”



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

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