Continuous auditory feedback for displaying automation status, lane deviation, and headway in a heavy truck

Pavlo Bazilinskyy, Pontus Larson and Joost de Winter – June 15, 2017

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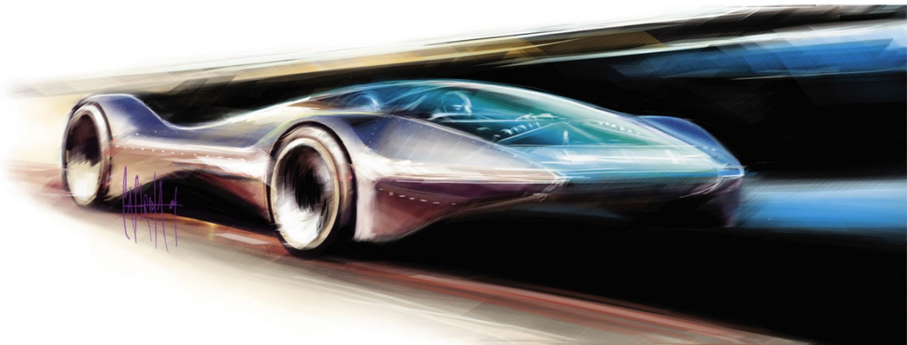
Structure of presentation

1. Experiment
2. First results
3. Conclusions and future work



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14 researchers and 15 partners

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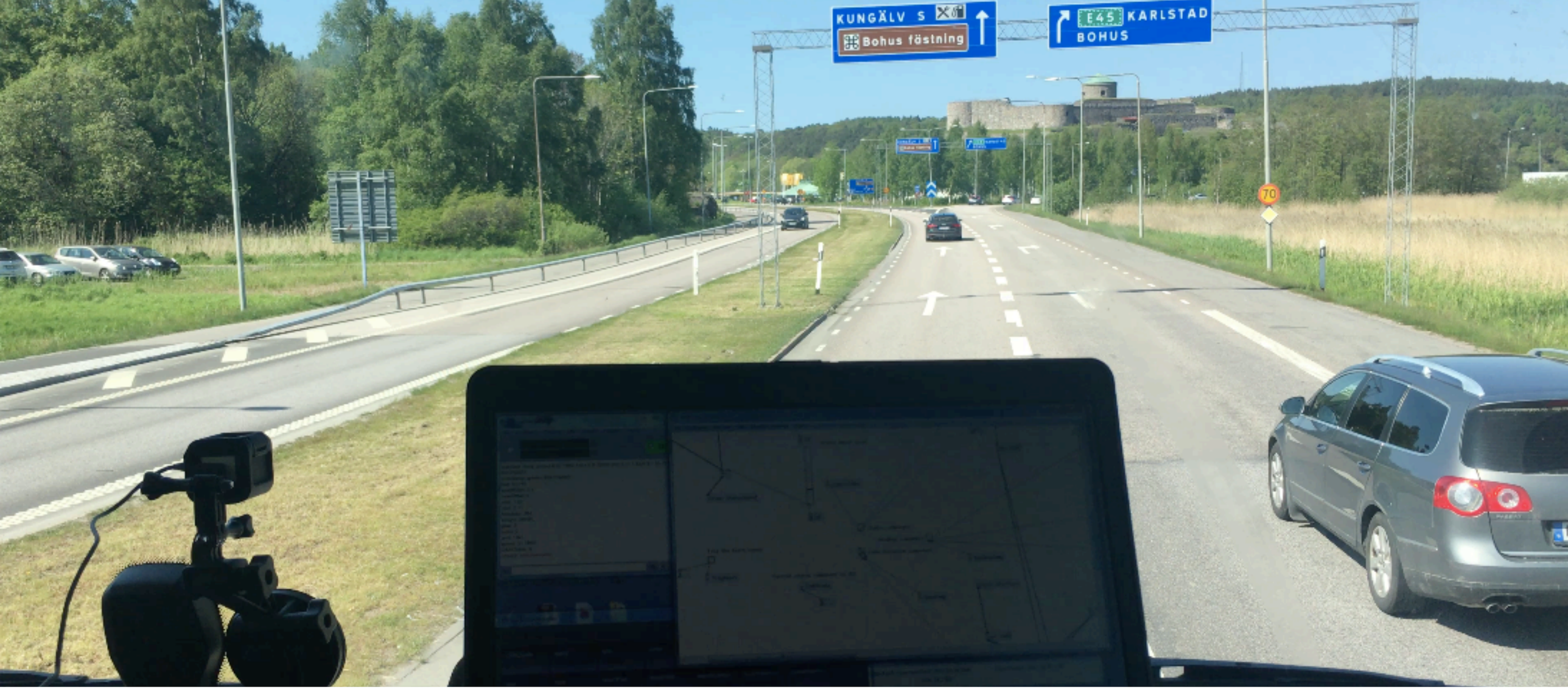

Experiment

on road in a long haul truck
on road = realistic noise level in cabin

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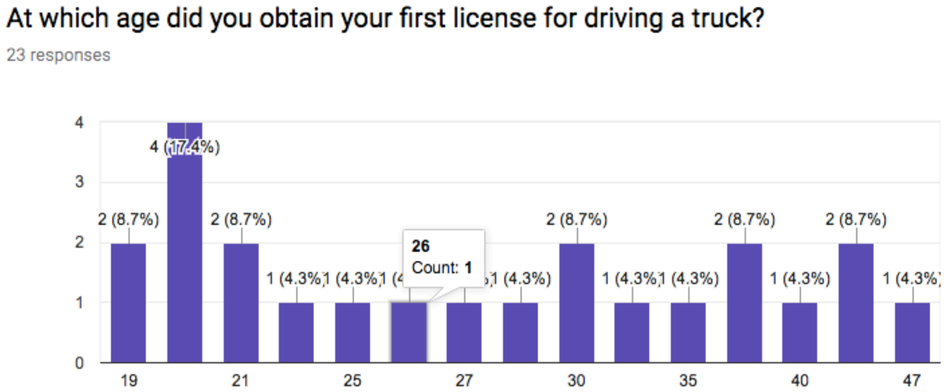
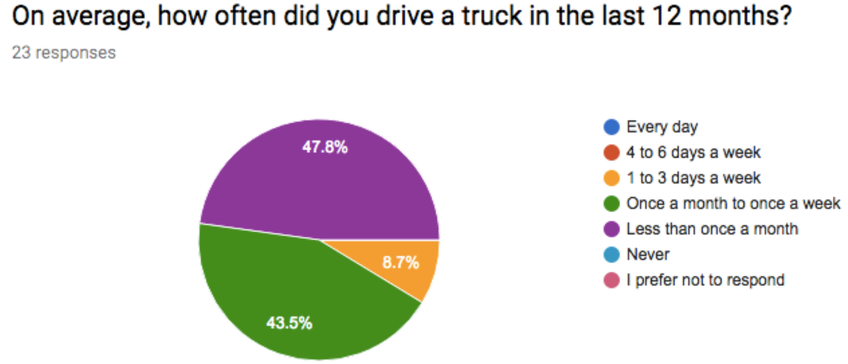
Participants

- 25 (20 male) employees of Volvo Trucks.
  - Average age: 49.5 years.
  - No prior knowledge of the offered systems.





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Equipment

- FH460: long haul truck from Volvo Trucks.
  - Equipped with **ACC** and **lane departure warning system**.
  - In experiment: rigid body experimental vehicle with no load.
- Video recording with 2 GoPro cameras.
- Audio recording with Olympus HQ microphone.
- Data logging via CAN interface.
- External GPS receiver.

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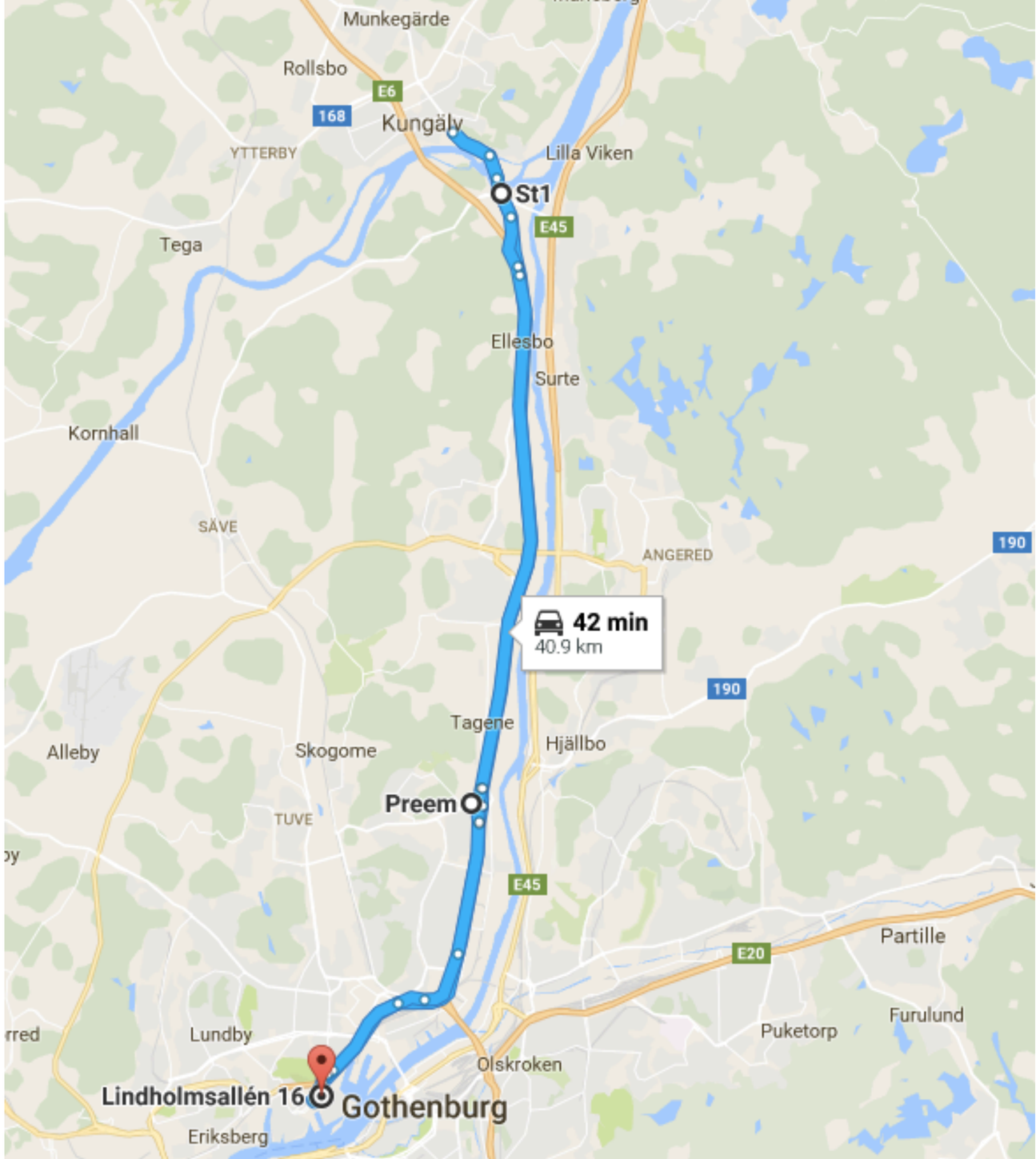
Route

- 40 min of driving on E6 near Gothenburg.
- 4 sessions of around 10 min each with breaks for questionnaires in between.
  - Trial 1: standard feedback.
  - Trial 2: **status of ACC**.
  - Trial 3: **lane position** then **time headway**.
  - Trial 4: **status of ACC** + **lane position** + **time headway**.
- 60–75 min in total.



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Auditory feedback

- **Status of ACC**
  - Sound similar to wind noise when ACC is ON.
- **Position in the lane**
  - Low pitch sound moving right when truck gets close to right edge, moving left when truck gets close to left edge.
- **Time headway**
  - Sound similar to wind noise with increasing amplitude as truck gets close to the vehicle in front.

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Results

image from www.ew.com

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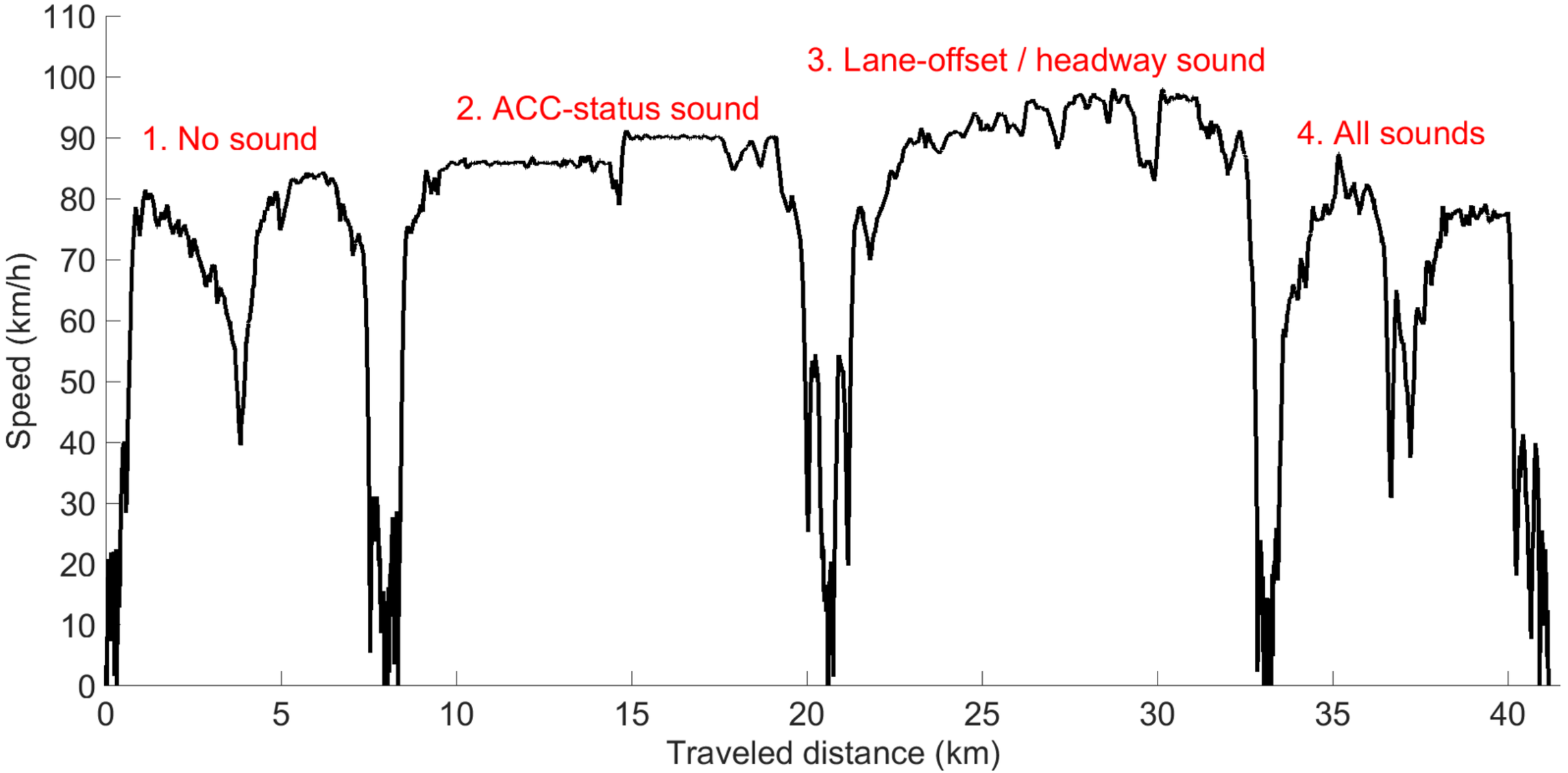

Driving speed for a selected participant

In Phase 2 (9.5–19.5 km) and in the last part of Phase 4 (38–40 km), the ACC was active as can be seen from the constant speed.

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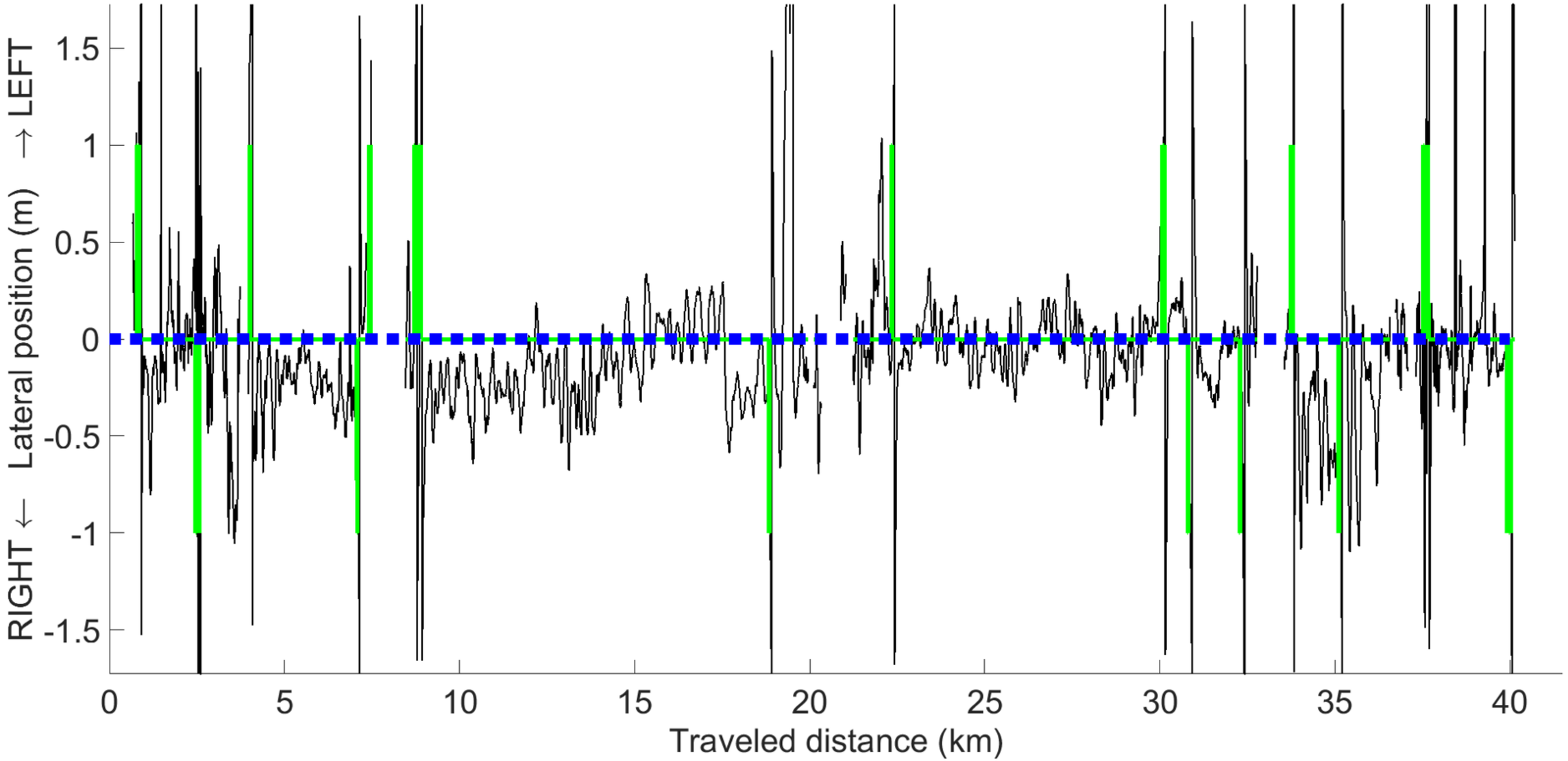

Lateral position (black) and use of the turn indicator (green; 1 = left, -1 = right) for the same participant as in previous figure

Data are shown only when the driving speed was greater than 50 km/h. In Phase 4 (34–35 km), the participant drove to the right of the lane for a prolonged time in order to hear the lateral offset sound. Lane width is about 3.5 m. Considering that the width of the truck is about 2.5 m, an absolute lateral position of 0.5 m or greater corresponds to driving on the lane markers.

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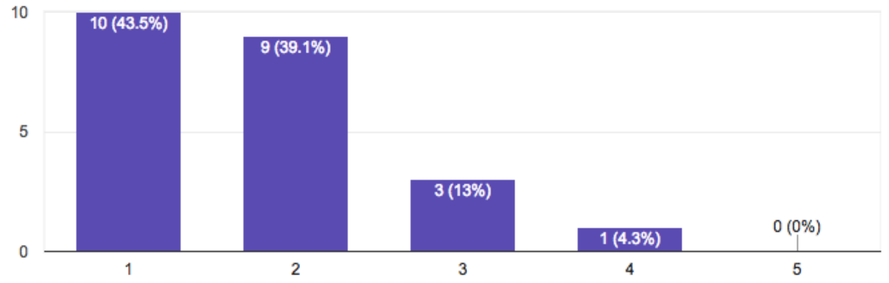
Auditory feedback on status of ACC

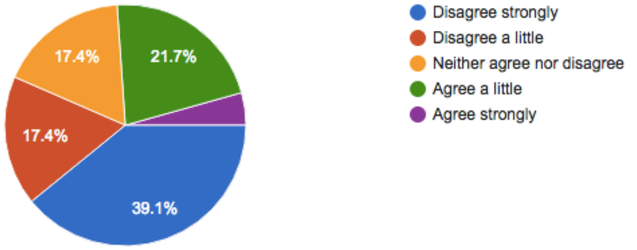
I think that I would like to use this auditory feedback frequently.

23 responses



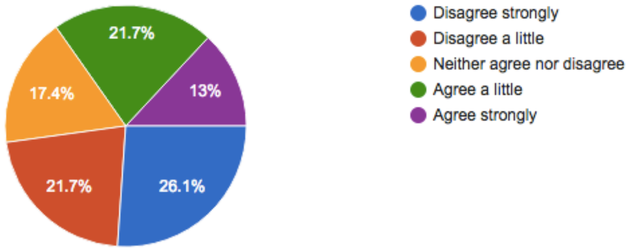
The continuous auditory feedback on the status of ACC that I heard is pleasant.

23 responses



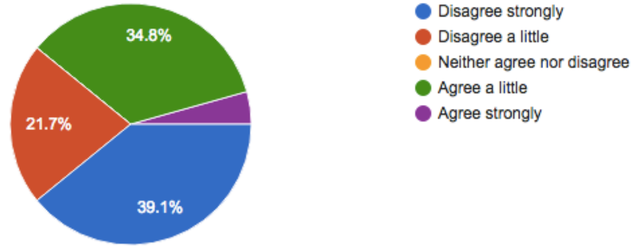
The continuous auditory feedback on the status of ACC that I heard is not annoying.

23 responses



The continuous auditory feedback on the status of ACC that I heard is useful.

23 responses



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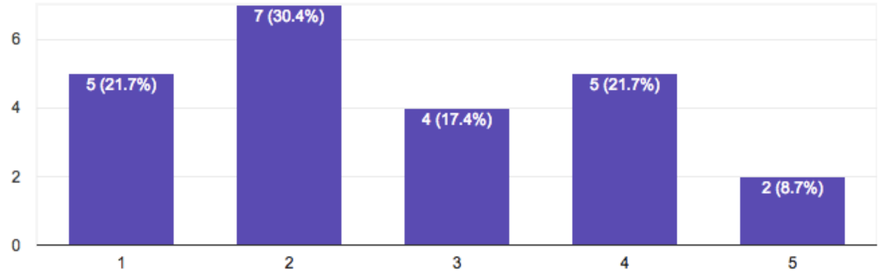
Auditory feedback on position in the lane

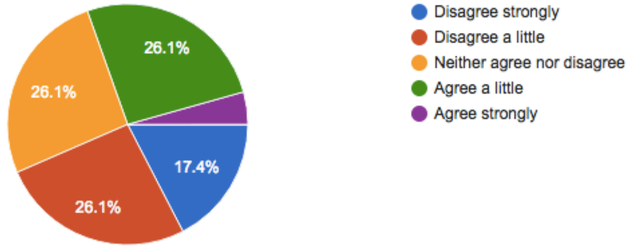
I think that I would like to use the continuous auditory feedback on the position of the truck in the lane frequently.

23 responses



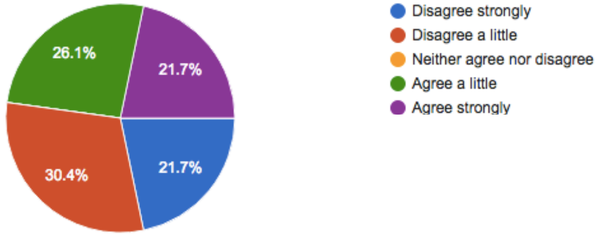
The continuous auditory feedback on the position of the truck in the lane that I heard is pleasant.

23 responses



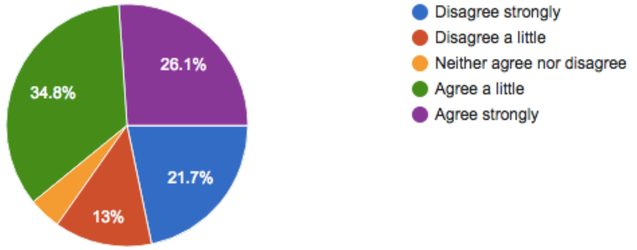
The continuous auditory feedback on the position of the truck in the lane that I heard is not annoying.

23 responses



The continuous auditory feedback on the position of the truck in the lane that I heard is useful.

23 responses



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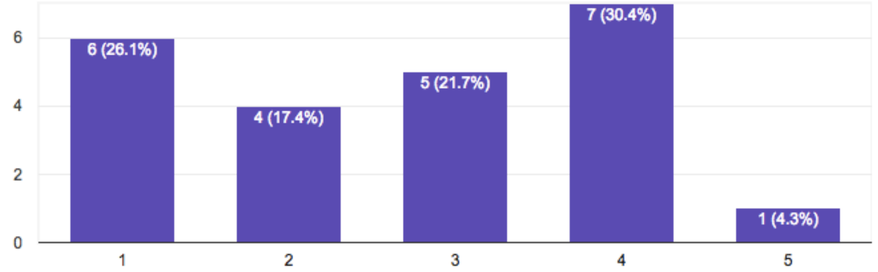
Auditory feedback on time headway

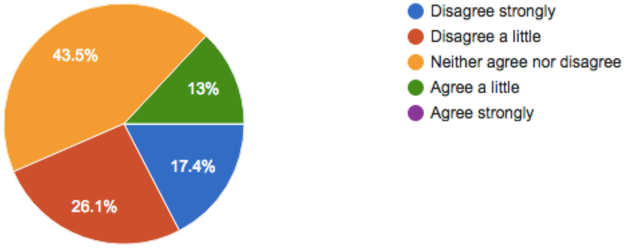
I think that I would like to use the continuous auditory feedback on the headway time to the vehicle in front frequently.

23 responses



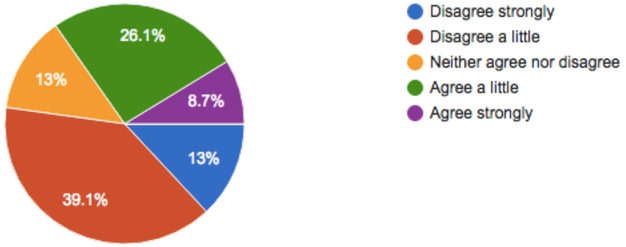
The continuous auditory feedback on the headway time to the vehicle in front that I heard is pleasant.

23 responses



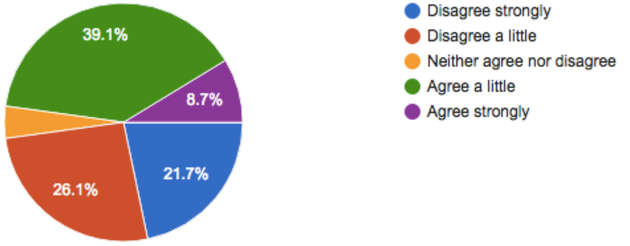
The continuous auditory feedback on the headway time to the vehicle in front that I heard is not annoying.

23 responses



The continuous auditory feedback on the headway time to the vehicle in front that I heard is useful.

23 responses



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Conclusions and future work

- Very mixed opinions on the offered feedback.
  - Common result for auditory feedback.
  - Many participants did not like the idea of adding additional noise.
- Feedback on position in the lane may have future applications.
- The inverted model for feedback on status of ACC may be investigated.
- Application of continuous auditory feedback on status of automation in an autonomous truck/car may be investigated.

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Thank you for your attention.
Any questions?

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