UTDRIVE CORPUS MANUAL

Sponsored by NEDO, Japan and Project EMITT at UTDallas

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The UTDrive project, directed by the Center for Robust Speech Systems (CRSS), University of Texas at Dallas is sponsored by grants from New Energy and Industrial Development Organization (NEDO), Japan and The University of Texas at Dallas at Dallas under Project EMMITT to collect rich multi-modal data recorded in the car environment, and conduct research regarding modeling driver behavior for smart vehicle systems. This report summarizes the progress of Feb. 2006 – Nov. 2007 period. The main objective of this period is to setup our data-collection vehicle and procedures, collect a core first-set of data, perform preliminary analysis, and ensure that our procedures are consistent with those used y our NEDO partners in Japan and Turkey.

The authors would like to thank Dr. Kazuya Takeda, Dr. Huseyin Abut, Dr. Wooil Kim, Dr. Ayako Ikeno, CRSS members, and senior-student assistants for their supports and contributions in the UTDrive project. The authors also thank Sonja Miley and Sandra Zemcik for their help in administrative assistance.

SECTION 1: OVERVIEW OF UTDRIVE CORPUS:

OBJECTIVES OF CORPUS

In society today, driving has become one of the essential activities in our lives, and hence driver awareness has been a major safety concern. Many events inside and outside the vehicle can divert a driver's attention from the road. In the US, about one-third of fatal accidents cause by reckless driving, and this does not include numerous crashes and injuries. With the current advances in technology and entertainment systems transferred to the in-vehicle, it is inevitable for a driver to experience them while driving. Unlike drunken driving, these in-vehicle applications are considered beneficial for drivers. However, distractions caused by operating this equipment can also lead to a fatal accident. Therefore, the study and analysis of the effect of distractions on a driver is indispensable in developing more effective in-vehicle applications which improve safety. Assessment of driver behavior is very challenging, since it requires multidisciplinary areas such as cognitive science, computer science, statistics, psychology, philosophy, artificial intelligence, signal processing, and pattern recognition. In addition, building effective driver-behavior recognition frameworks requires a thorough understanding of human behavior and the construction of a mathematical model capable of both explaining and predicting the driver's behavioral characteristics. In recent studies, several researchers have defined different performance measures to understand driving characteristics. Such measures include driving performance, driver behavior, task performance, etc. In order to evaluate these measures, knowledge from various driving signals is necessary. Therefore, multi-modal data acquisition is very important in these studies. As previously mentioned, researchers have defined different performance measures to better understand and explain driving characteristics. Such measures include:

- Driving performance measures consist of driver inputs to the vehicle or measures of how well the vehicle was driven along its intended path. Driving performance measures can be defined by
    - Longitudinal velocity and acceleration
    - Standard deviation of steering-wheel angle and its velocity
    - Standard deviation of the vehicle's lateral position (lane keeping)
    - Mean following distance
    - Response time to brake
- Driver behavior measures can be defined by
    - Glance time
    - Number of glances
    - Awareness of drivers
- Task performance measures can be defined by
    - Time to complete the task
    - Quality of the completed task

Furthermore, in addition to understanding the driver behaviour, the audio sub-corpus of UTDrive Corpus can be used to develop in-vehicle speech based communication and driver assistance systems.

Summary of Publications: UTDrive program

JOURNAL PUBLICATIONS:

[1.] A. Sathyanarayana, J.H.L. Hansen, "Impact of Secondary Tasks on Individual Drivers: Not All Drivers are Created Equally," *SAE Inter. Journal on Passenger Cars - Electronic & Electrical Systems*, vol. 5, pp. 414-420, doi:10.4271/2012-01-0486, Sept. 2012

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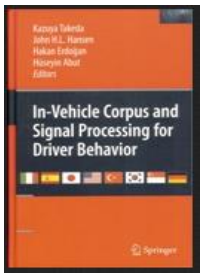

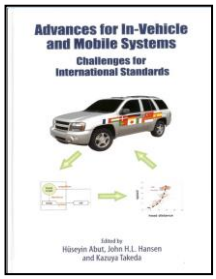

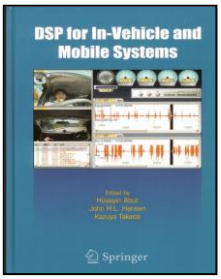

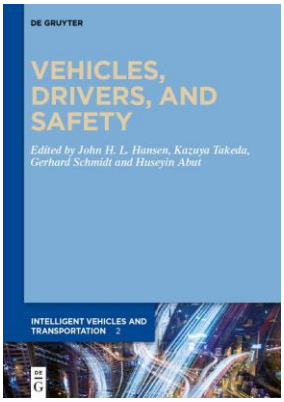

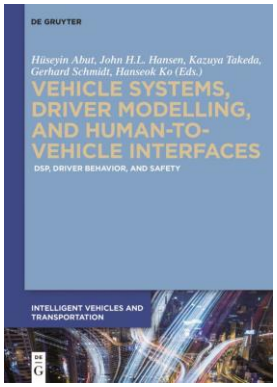

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DATA COLLECTION HARDWARE

Input Signals

In order to accomplish our goals, the UTDrive's data-collection vehicle is particularly designed to collect the following signals:

- Audio
- Video
- Brake/Gas pedal pressure
- (Controller Area Network) CAN-Bus information
- Following distance
- Vehicle location (GPS)
- Driver's biometric

1. Audio

A custom designed five microphone array with omni-directional microphones was installed on top of the windshield next to the sunlight visors to capture audio signals inside the vehicle. Since there are various kinds of car background noise (e.g., A/C, engine, turn-signals, vehicles passing) presented in driving environments, the microphone array configuration will allow us to apply beam-forming algorithms to enhance the quality of input speech. In our setup, each microphone was mounted in a small movable box individually attached to an optical rail, as shown in Figure.

Figure 1: Five-channel microphone array configuration.

This particular design allows the spacing between each microphone of the array to be adjustable across the width of the windshield (e.g., linear, logarithmic, etc.). One of our studies showed that logarithmic scale outperformed linear scale in terms of SNR improvement for some noise conditions, with a basic delay-and-sum beam-forming processing. The optimization of array configuration and beam-former processing is another challenge which is being considered.

In addition, the driver speech signal is also captured by a close-talk microphone (Shure Beta-54) which was connected to a phantom power supply. This microphone provides the reference speech of the speaker, and allows the driver to move their head freely while they are driving the vehicle.

2. Video

Two Firewire cameras are used to capture visual information of driver's face region and front-view of the vehicle, as shown in the following figure. Real-time computer vision is an important component to understand driver behavior (e.g., face and eyes detection to measure driver glances). In addition, studies have shown that combining audio and visual information of driver can improve ASR accuracy of low-SNR speech. Integrating both visual and audio contents allows us to reject unintended speech prior to speech recognition and significantly improve in-vehicle human-machine dialog system performance (e.g., determining the movement of the driver's mouth, body, and head positions).

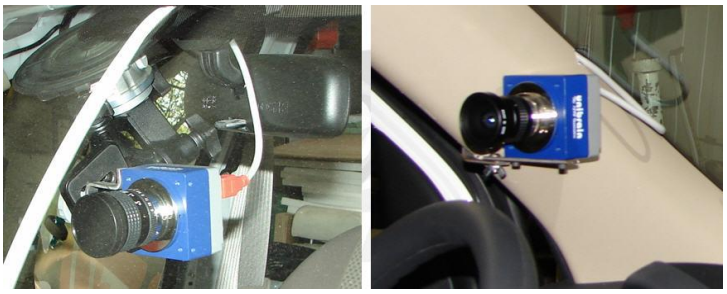


Figure 2: Two video cameras.

3. CAN-Bus Information

As automotive electronics advance and government required standards evolve, control devices that meet these requirements have been embracing modern vehicle design resulting in the deployment of a number of these electronic control systems. The Controller Area Network (CAN) is a serial, asynchronous, multi-master communications protocol suited for networking vehicle's electronic control systems, sensors, and actuators. The CAN-Bus signals contain real-time vehicle information in the form of messages integrating many modules, which interact with the environment and process high and low speed information. In the UTDrive project, we obtain the CAN signals from the OBD-2 port through the 16 points J1962. Messages captured from CAN while the driver is operating the vehicle (e.g., steering wheel angle, brake and gas pedals, vehicle speed, engine speed, and vehicle acceleration) are desired to study driver behavior. Studies have shown that driver behavior can be modeled and predicted by the patterns of driver's control of steering angle, steering velocity, car velocity, and car acceleration, as well as driver identity itself.

4. Transducers and Extensive Components

In addition, the following transducers and sensors are included into the UTDrive framework:

- Brake and gas pedal pressure sensors: provides continuous measurement of pressure, compensating the binary information (on/off) obtained from CAN-Bus.

Figure 3: Brake and Gas pedal pressure transducers.

- Distance sensor: provides the forward distance to the next vehicle.

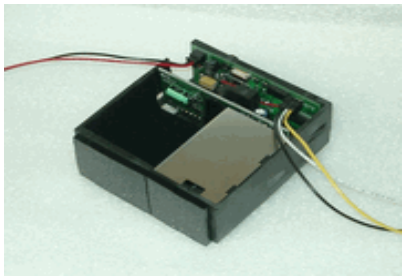


Figure 4: Distance sensor.

- GPS: provides standard time and position of vehicle.

Figure 5: GPS unit.

- Hands-free car kit: provides safety during data collection and audio data of both audio channels to be recorded.

Figure 6: Hands-free car kit.

5. Data Acquisition Unit (DAU)

The key component of multi-modal data collection is synchronization of all data. In our data collection, we use a fully integrated data acquisition unit, namely DA-121, supplied by Dewetron. With a very high sampling rate of 100 MHz, DA-121 is capable of synchronously recording multi-range input data (i.e., 16 analog inputs, 2 CAN-Bus interfaces, 8 digital inputs, 2 encoders, and 2 video cameras), and yet allows sampling rate for each data to be set individually. DA-121 can export all recording data as a video clip in one output screen, or individual data in its proper format (e.g., .wav, .avi, .txt, .mat, etc.) with synchronous time stamps.

Figure 7: Data Acquisition Unit (DA-121).

Since the analog input channel of the DAC is BNC connector, it is necessary for us to built addition cables to adapt different connectors to the BNC connector.

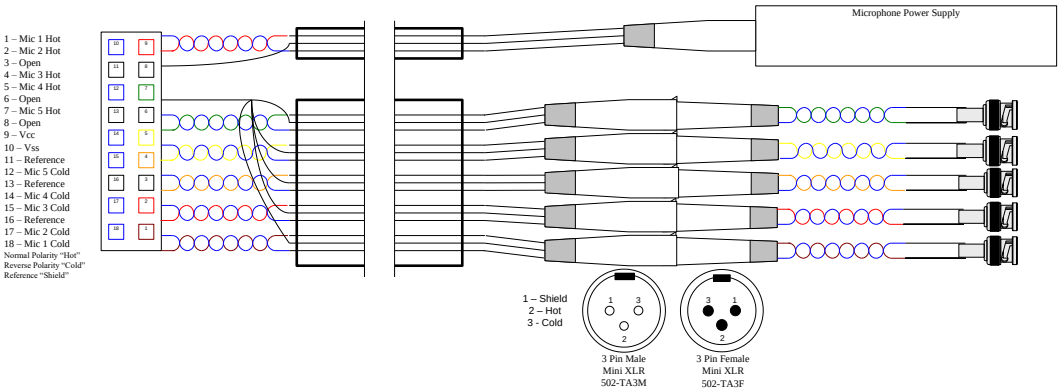


Figure 8: A sample of XLR-BNC cable design.

Figure 9: UTDrive's data-collection vehicle and its components.

DATA COLLECTION PROCEDURE

For data collection, each participant will drive the vehicle following two different routes (closed loops) in the neighborhood areas of the UTD campus (Richardson-Dallas, TX); the first route represents a residential area environment and the second route represents a business district environment. Each route takes approximately 10-15 minutes to complete one round--clock-wise direction for Route-1 and counter-clockwise direction for Route-2. The participants are encouraged to drive the vehicle for three sessions, with at least one week separation between sessions. Unless volunteering, participant will receive $25 compensation for completion of the first session, $25 for completion of the second session, and $50 for completion of the third session. For each session, participant will drive vehicle approximately 1 hour following these two routes for three to four rounds depends on the time constraint.

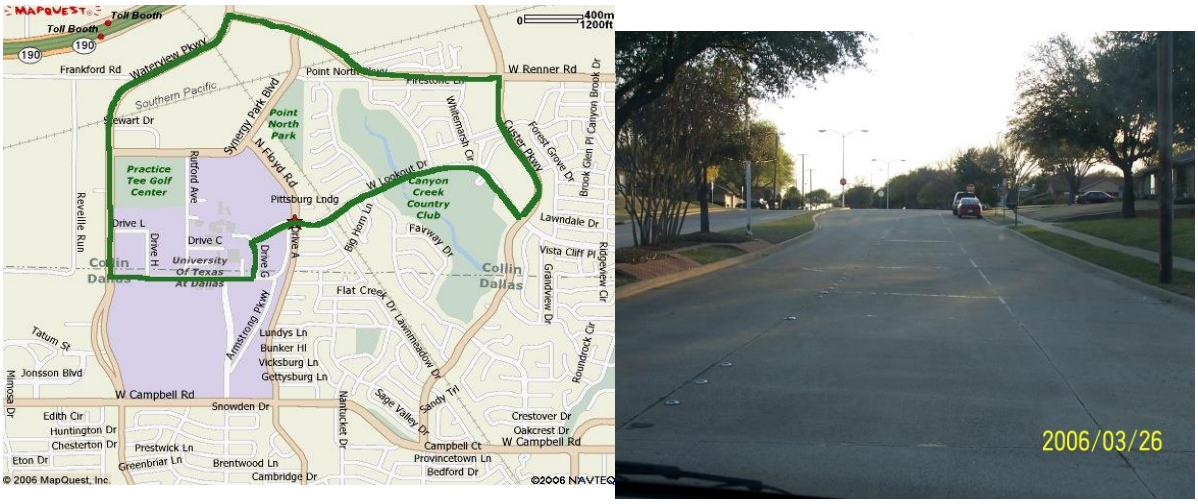


Figure 10: Route-1 map and a snapshot of a driving scene.

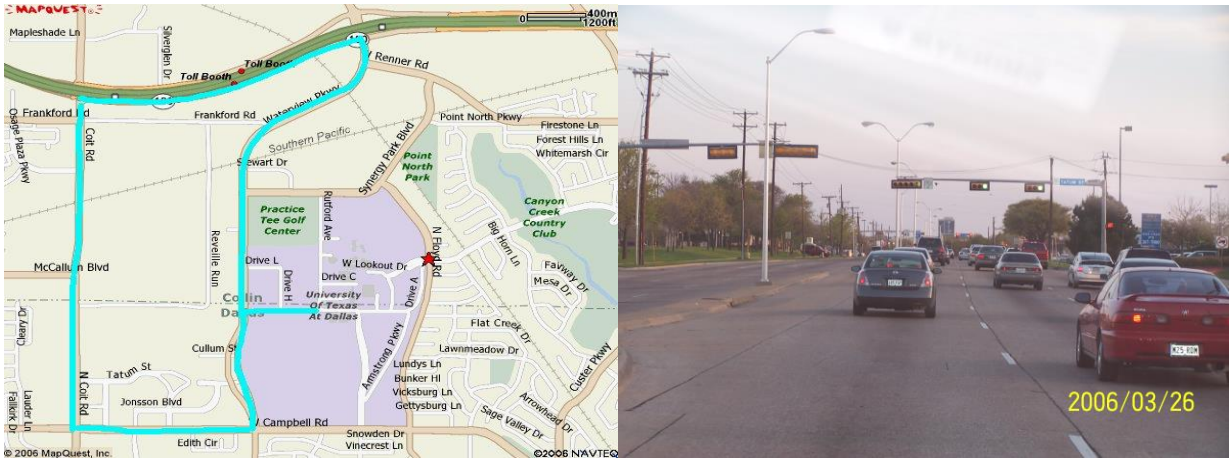


Figure 11: Route-2 map and a snapshot of a driving scene.

For each round, data collection will be start and end at the same parking lot and participant will be asked to drive vehicle with different scenarios as the followings:

- Session 1
  - Route 1 : Free-style/Normal driving
  - Route 1 : Assigned tasks A
  - Route 2 : Assigned tasks A
  - Route 2 : Free-style/Normal driving

- Session 2
  - Route 1 : Assigned tasks B
  - Route 1 : Free-style/Normal driving
  - Route 2 : Free-style/Normal driving
  - Route 2 : Assigned tasks B

- Session 3
    - Route 2 : Assigned tasks C
    - Route 1 : Assigned tasks C
    - Route 2 : Free-style/Normal driving
    - Route 1 : Free-style/Normal driving

Participant will be given only driving direction during the normal/free-style driving. There is no assigned distraction task so that driver can focus on the road. The route with assigned tasks means participant will drive and be asked to perform some secondary task while driving. Due to safety concerns, the assigned tasks are common tasks with mild to moderate degrees of cognitive load. Participants can refuse to perform any tasks which they do not feel comfortable to do. The assigned tasks are listed as follow:

- Interacting with commercial dialog systems via cell-phone interface from the vehicle:
    - American Airline (AA)--airline arrival and departure information as shown in Table 1.
    - TellMe--information voice portal as shown in Table 2.

The driver calls the pre-dialed telephone numbers to have interaction with AA to check on gate information of a flight of interest, and TellMe to ask for any information of interest (e.g., sport, entertainment, stock quote, etc.)

With respect to safety concerns, the driver uses a hands-free car kit when interacting with the telephone system. Definitions of tasks are given as follows:

- Common tasks: Driver will be asked to turn-on the radio, change radio station, open window, etc.
- Sign Reading: Driver will be asked to read the signs on the street (e.g., sign board, street name, license plate number)
- Conversation: Driver will have general conversations with the UTDrive monitoring staff.
- Spontaneous: Driver will be asked to talk continuously for a couple minutes on general topics.
- Lane changing

Appendix A and B show two driving routes and the assigned tasks for each section.

American Airlines

AA: Thank you for calling American Airlines. This call may be recorded for quality assurance. For assistance in English Please press 1.

Driver: [presses 1]

AA: Welcome to the fight information system for American airlines, American Eagle, American Connection, and other American marketing couch air fights.
To get you up to date on departure and arrival information I am going to ask you a few questions. First what is the flight number, its ok to say I don't know.

Driver: I DON'T KNOW

AA: Ok… lets find out which flight you want,
What is the departure city?

Driver: DALLAS FORTH WORTH

AA: Next tell me the arrival city.

Driver: NEW YORK LGA

AA: Thanks! Now Is that for departure or arrival info?

Driver: DEPARTURE

AA: And, finally around what time does that flight depart

Driver: 5 PM

AA: Let me make sure that I got that right
..... [Confirming information]
Did I get that right?

Driver: YES

AA: One moment. FLIGHT.....
Remember the gate information and the terminal can change. Please make sure to look for the flight

Table 1: A Sample dialog from American Airline system.

```
TELLME:

TELLME: Main menu. Hear all the categories you can choose from Business
search [ring tones] stock quotes, news center, sports, entertainment,
travel, and popular shortcuts.
      That's all the categories. Now go ahead and say the one you want

Driver: Sports.

TELLME: I am sorry. I didn't hear you.
      Just say a category or say main menu to hear all the categories
you can say.

Driver: Sports.

TELLME: I am sorry. I still didn't hear you.
      Say a category or enter the first 3 letter on the telephone keypad
for instance for SPORTS enter SPO.
```

Table 2: A sample dialog from TELLME system.

SECTION 2: SIGNAL PROPERTIES, DATA STRUCTURE AND HARD DISK DISTRIBUTION

MAIN SIGNAL PROPERTIES

A snapshot of data recording screen is given in Figure 12. Using this screen data collector can track any interruption or malfunctioning sensor during the session.

Figure 12: A snapshot of data recording screen.

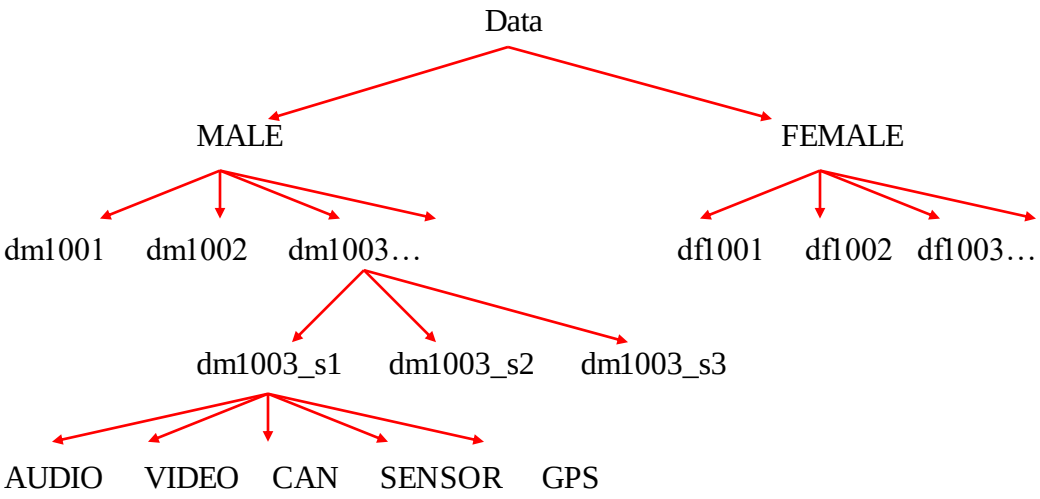
At the present, a set of complete data acquisition has up to 21 channels as shown in Table 3 (Each data set contains at least two videos, one audio, and brake/gas pedal pressures or CAN-Bus message):

Signal	Acquisition Rate	Min. Value	Max. Value
Microphone Array CH#1	25000		
Microphone Array CH#2	25000		
Microphone Array CH#3	25000		
Microphone Array CH#4	25000		
Microphone Array CH#5	25000		
Close-talk Microphone	25000		
Gas-pedal pressure sensor	100	0.50	0.80
Brake-pedal pressure sensor	100	-0.30	0.80
CAN: Steering wheel Left/Right	79.5	0	15
CAN: Steering wheel Degree	79.5	0	255
CAN: Steering wheel Holding	50.0	0	255
CAN: Brake Count	39.8	0	255
CAN: Brake Pressure	39.8	0	7
CAN: Brake Hit	39.8	0	1
CAN: Brake Value	39.8	0	1
CAN: Engine RPM	31.5	0	255
CAN: Vehicle Speed (km/h)	2.0	0	255
GPS: X-absolute	1.0	-1000	1000
GPS: Y-absolute	1.0	-1000	1000
GPS: Velocity (km/h)	1.0	0	300

Table 3: Recording data and acquisition rate.

UTDRIVE CORPUS DATA STRUCTURE

Directory structure (Data → Gender → Driver ID → Session → Signal → Files)



Filename

"DriverID_session_part_[r]_yyyy_mm_dd_tttttt_signal.wav"

e.g., dm1001_s1_p1_2007_02_10_163110_AI_1.raw

DriverID	dm1001	=> Driver id number: d = Dallas, m = male, f = female, 1001 = 1st driver (1001, 1002, 1003, …)
session	s1	=> session id: s1 = session 1, …, s3 = session 3
part	p1	=> part number: p1 = part 1, …,p4 = part 4
[r]	2	=> sub-sections of files (if there are more than one): 1, 2,…
yyyy_mm_dd	2007_02_10	=> date of data collection
tttttt	163110	=> time of data collection (16:31:10 o'clock)
signal	AI_1	=> type of signal/measurement

Signal/Measurement & File Format

AUDIO (16 kHz, 16-bit linear, RAW format)

- AI_1 Far-filed Microphone (the 2nd channel of microphone array which directly faces the driver).

VIDEO (640*480 Resolution, 15 frame/sec)

- CAM_0 front-forward camera

- CAM_1 driver-face camera

SENSOR (100 Hz, floating point, RAW format separate channels or MAT format combined)

- Gas_6 Gas-pedal pressure sensor
- Brake_7 Brake-pedal pressure sensor

CAN (100 Hz, 16-bit linear, RAW or MAT format)

- CAN_ACC_RPM Accelerator RPM measurement
- CAN_BRK_CNT Approximate slope of Brake Value
- CAN_BRK_HIT Sudden brake press
- CAN_BRK_PRESS Brake is ON or OFF
- CAN_BRK_VALUE Pressure value on the brake
- CAN_STR_DEGREE Angular degree of steering wheel
- CAN_STR_HOLD Steering wheel movement
- CAN_STR_LR Steering wheel LEFT or RIGHT turn
- CAN_VEH_SPEED Vehicle Speed (km/h)

Note:
In case of recording malfunction, multiple sub-section of CAN signal will be represented as CAN1, CAN2, CAN3…
Consequently, gathering CAN1, CAN2 … together will represent CAN signals of the whole driving route (e.g., s1_p1_CAN1 + s1_p1_CAN2 + … = s1_p1_CAN).
An illustration of original data structure is given in Figure 13.

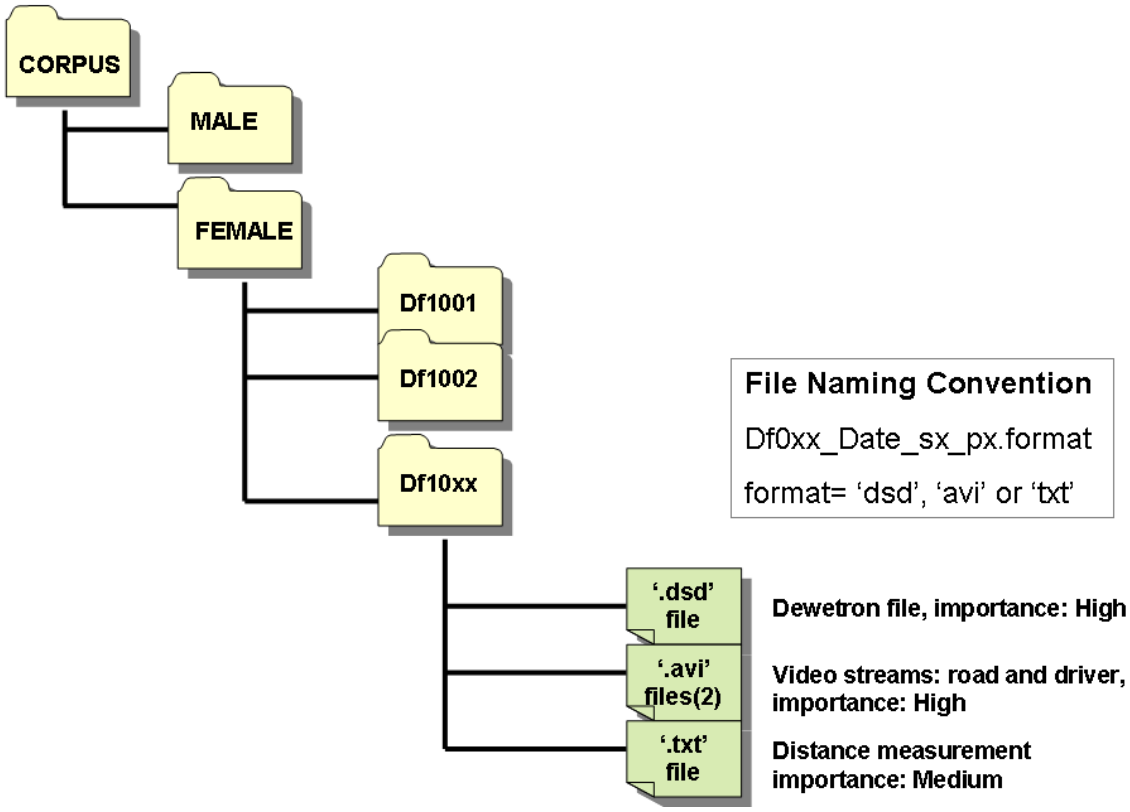


Figure 13: UTDrive Corpus Original Data File Structure

After saving the original data in server, the channels are retrieved and stored under 'UTDrive Corpus Exported Data' folder in the structure shown in Figure 14.

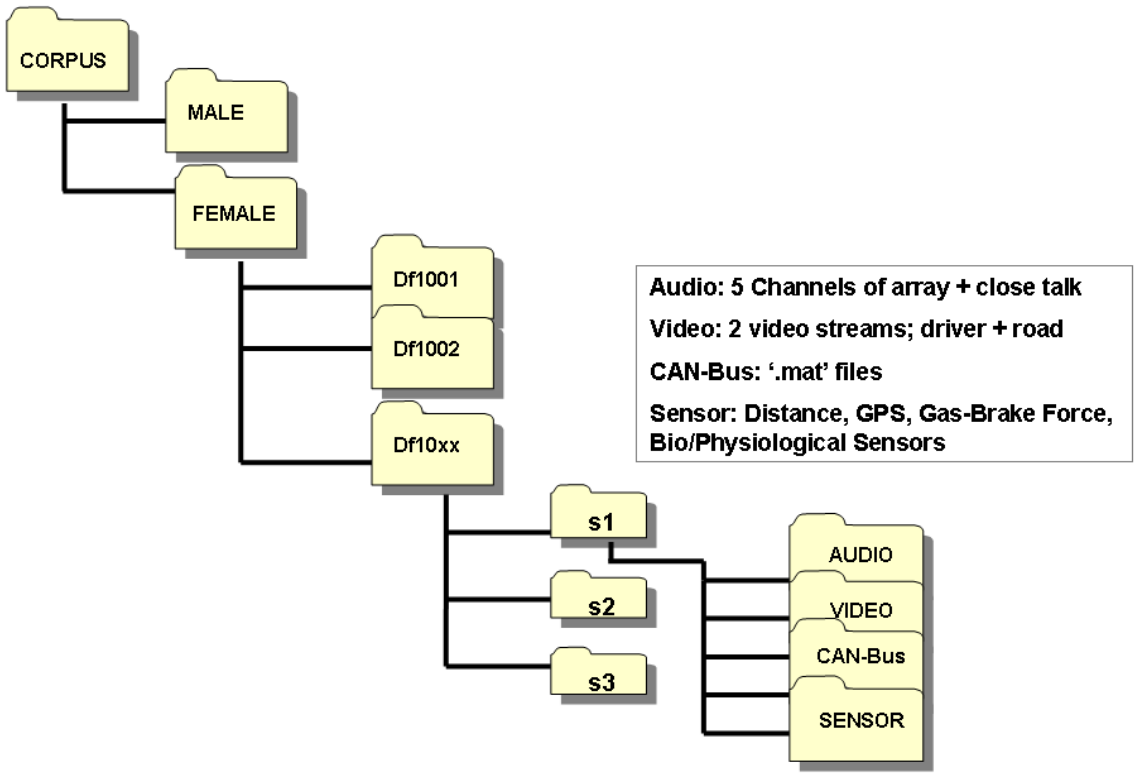


Figure 14: UTDrive Corpus Exported File Structure

CAN definition

CAN1_ACC_RPM.raw
This message holds the value of engine rpm. It can be closely associated with the average accelerator pedal press. A request from the driver for increase in vehicle speed is processed by pressing the accelerator pedal to increase or decrease the engine rpm which correspondingly varies the vehicle speed. Effectively, from this message we arrive at the driver demand for vehicle speed (acceleration pedal press).

CAN1_BRK_CNT.raw
This message is a counter, which counts the brake press during one brake-press event. The count can be 1,2,3,4..., or 1,5,7 ... depends on how the driver hits the brake. Driver might hit it slowly first and then harder later, or vice versa.

CAN1_BRK_HIT.raw
This message gives information if and when there is a sudden brake, i.e., the brake pedal is hit hard (say, 80-90% press of brake pedal).

CAN1_BRK_PRESS.raw
This message tells whether brake pedal has been pressed or not. It is binary information (on/off).

CAN1_BRK_VALUE.raw
This message holds the brake pressure value which represents how hard driver hits the brake.

CAN1_STR_DEGREE.raw
This message gives information concerning the steering degree. i.e., to what percent or to what degree in angle the driver has turned the steering wheel in making a turn or shifting lanes. This information varies based on how slowly or how fast the driver takes a turn, if the driver is turning fast, then the steering degree has to be quicker and lesser, but if the driver is turning slowly, then the steering degree has to be greater.

CAN1_STR_HOLD.raw
This message gives the time equivalent information for which the driver has held the steering without releasing it during a turn or any other maneuver.

CAN1_STR_LR.raw
This message gives us information on whether the steering wheel is turned towards the left or towards the right. The classification of this signal can be as extreme right, right, center, left and extreme left.

CAN1_VEH_SPEED.raw
This message holds the vehicle speed. The real-time vehicle speed not only depends on the acceleration demand, but also on other factors such as gradient of the road, vehicle momentum, and braking action. This message provides overall vehicle speed which the driver perceives and at which the vehicle is moving.

HARD DISK DISTRIBUTION:

Current state of stored original and retrieved/exported data is shown in Table 4.

Table 4: Hard disk distribution of original and exported data in UTDrive Corpus

No	Hard disk Label	Hardware	Content	File Structure	Progress
1	UTDrive Original	Western Digital 500GB	Original Data	please refer Figure 13	40M, 40 F drivers
2	UTDrive Exported	Western Digital 500GB	Exported Data	please refer Figure 14	in progress
3	UTDrive Exported (Back-up)	Maxtor 500 GB	Exported Data	please refer Figure 14	in progress
4	Original Copy 2	Maxtor 500 GB	mixed	NA	to be re-arranged
5	Original Copy 3	Maxtor 500 GB	mixed	NA	to be re-arranged
6	Back-up copy 2	Western Digital 500GB	mixed	NA	to be re-arranged
7	UTDrive-01	Maxtor 500 GB (old gray)	Copy of Original Data	please refer Figure 1	to be deleted

A data log is continuously being updated to track the completeness of the sessions in the database. Current state of this log is attached in Appendix C.

SECTION 3: TRANSCRIPTION PROTOCOLS AND TOOLS

PROTOCOLS:

Four basic categories of transcription in UTDrive Corpus are identified and detailed here. These categories are:

1. Maneuver based (Event-based) transcription
2. Driver status based transcription
3. Audio based transcription
4. Task-based transcription

Each category is explained and sub-layers of labeling, if any, are stated here.

1. Maneuver based (Event-based) transcription

There are five basic categories of maneuver and two regulatory driving task identified for city and highway driving as follows:

Basic maneuvers:	
RT	Right turn
LT	Left turn
LC	Lane change
TO	Take-over
ST	Stops

Regulatory tasks:	
LK	Lane keeping
CF	Car-following

A single layer transcription requires time tagging of starting (_S) and ending (_F) of the maneuver/ regulatory task. Frontal view video and CAN-Bus signals are used simultaneously to align the signals properly. Some of these maneuvers need a multi-layer transcription. These are RT, LT, LC, ST, and LK for the time being. TO and CF have secondary importance for the moment.

1.1. Right and Left Turns

RT and LT Second Level Transcription

This requires labeling the maneuvers with and without ***interruption***. Two labels are used for this: '_I' for interrupted, '_N' for neutral.

RT and LT Third Level Transcription

This requires labeling the maneuvers with regard to the traffic context in which they are taking place. A turn can be performed in a signaled or un-signaled intersection. Two labels are used for this: '_SIGN' for signaled, '_UNSIGN' for un-signaled.

1.2. Lane Changes

LC Second Level Transcription

Lane changes can occur after a prompt by experimenter during distracted driving or voluntarily during free-style driving sessions. They are different in nature and should be labeled to indicate so. Two labels needed for LC in second layer: '_P' for prompted and '_V' for voluntary.

LC Third Level Transcription

Since there are 2-lane and 3-lane roads on our route; a lane change can occur in 2 ways in 2-lanes and in 6 ways in 3-lane roads.

2-lanes: L-R (for left to right), R-L (for right to left)
3-lanes: L-M (left to middle), M-L (middle to left), R-M (right to middle), M-R (middle to right), L-M-R (left, middle, right/ double lane change), R-M-L (right, middle, left/ double lane change)

1.3. STOP (ST)

STOP Second Level Transcription
Stops may be prompted by signs, traffic lights, congestion (stop-go behaviour) or obstacle/ interruption (i.e. pedestrians). Therefore these need labeling as follows: '_SIG', '_LIGHT', '_CON' and '_OBS'.

1.4. Lane Keeping (LK)

LK Second Level Transcription

The roads can be straight or curved sometimes a combination of these in sequence. Therefore segmentation between the straight lane keeping and curved lane keeping tasks needs to be done. For this, we use '_STR' for straight, '_CUR' for curved segments.

According to this labeling convention a maneuver will be labeled as follows:

'RT1_first_second_third'; RT= maneuver name, 1: maneuver number within the session, first: first layer label, second: second layer label, third: third layer label.

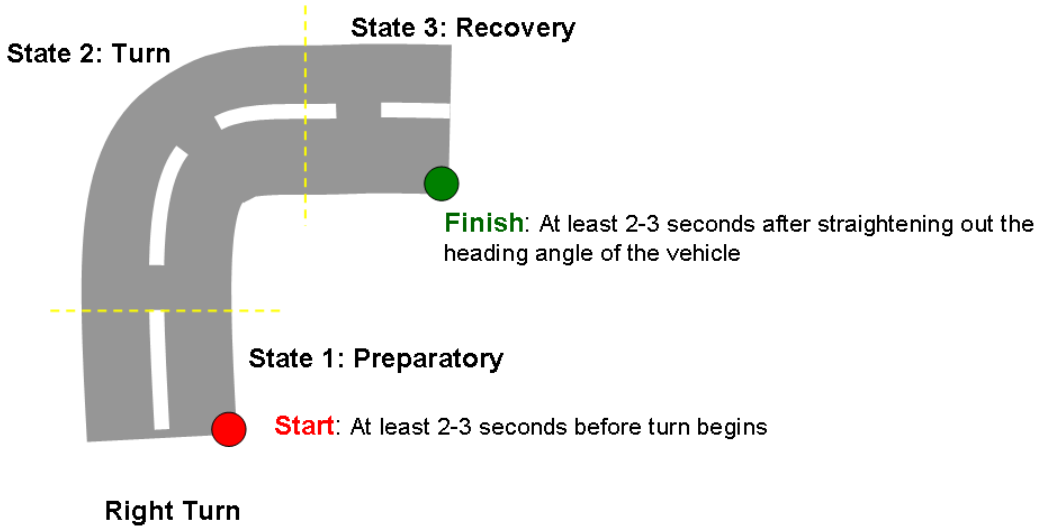


Figure 15. Right turn definition

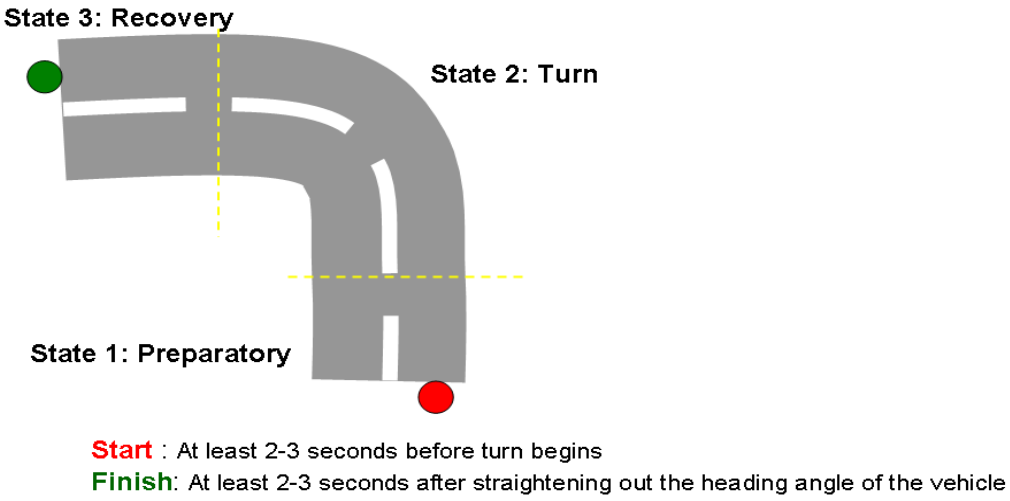


Figure 16. Left turn definition

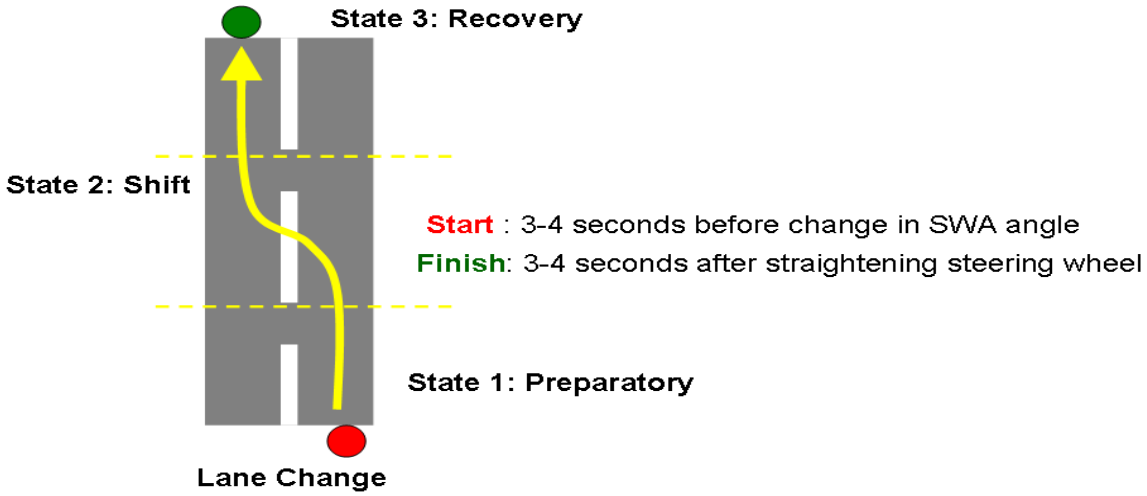


Figure 17. Lane change definition

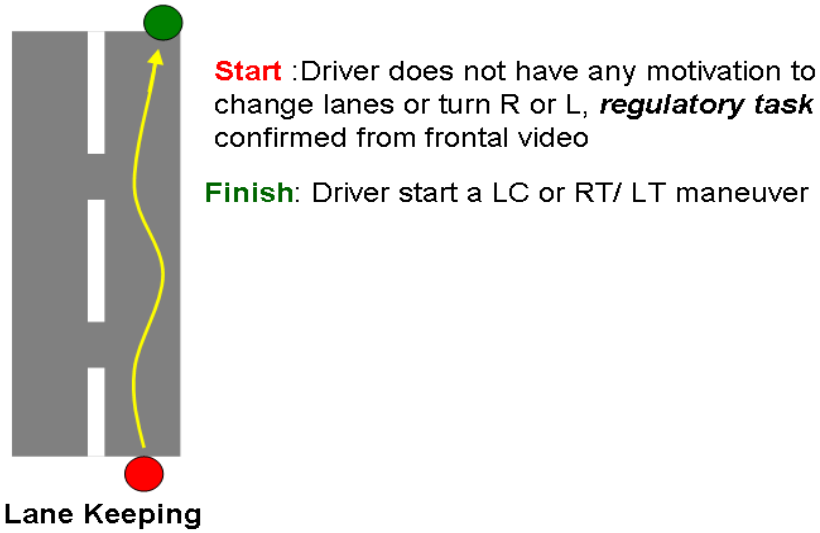


Figure 18. Lane keeping regulatory task definition

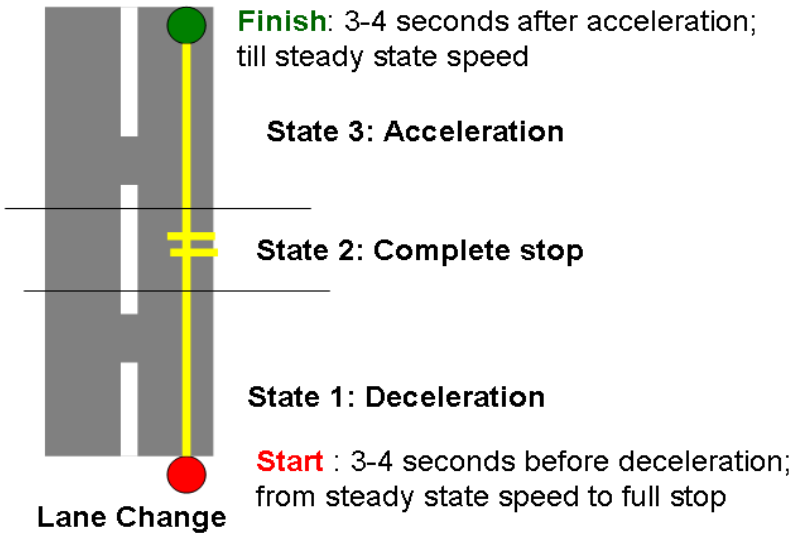


Figure 19. Definition of stop

2. Driver status based transcription

This category is needed for obtaining the ground truth for head tracking, eye tracking and emotional state detection work in future. The details of this work will be provided later here.

3. Audio based transcription

Audio based category is needed in three different ways:
3.1. Word-by-word utterance transcription
3.2. Emotional state labeling from human perception (ground truth building)—subject to demand
3.3. Start and end of several audio tasks, i.e. Dialog system interaction, conversation, and road sign reading, free style driving talk (if it exists)

4. Task-based transcription

All the tasks (audio, cognitive, manual, visual) should be marked in the first layer for start and finish times using audio and video channels.

PROGRESS

Transcription category	Progress
Maneuver based (Event-based) transcription	30 M driver on RT, LT and LC, 8 M driver on LK straight segments
Driver status based transcription	None, subject to time availability
Audio based transcription	3.1. 18 F, 8M drivers 3.2 and 3.3 to commence
Task-based transcription	To commence

TOOLS:

Transcription tools for video are Virtual Dub and ANVIL. For audio transcriptions, WaveSurfer is used. Both video and audio transcription tools are open source. CAN-Bus transcriptions are based on a MATLAB code developed in CRSS, available upon request.

SECTION 4: GLOBAL DATA STATISTICS

UTDrive corpus is managed to be demographically well balanced and distributed in terms of age, gender and driving experience to represent driver behaviour realistically. Here is the brief description of the database is given with each category.

Age Distribution

Age factor in driving has two contradictory affects on the driving behaviour. Elderly drivers tend to have more driving experience and can follow the rules with less error; however, their reflexes and reaction times might be slower compared to younger drivers. On the other hand, the young drivers have better reflexes and faster response times, however the safety margin tend to be much lower and most of them can be grouped in novice driver class. A summary of age distribution in UTDrive Corpus (37 F, 40 M currently) is given in Figure 1.

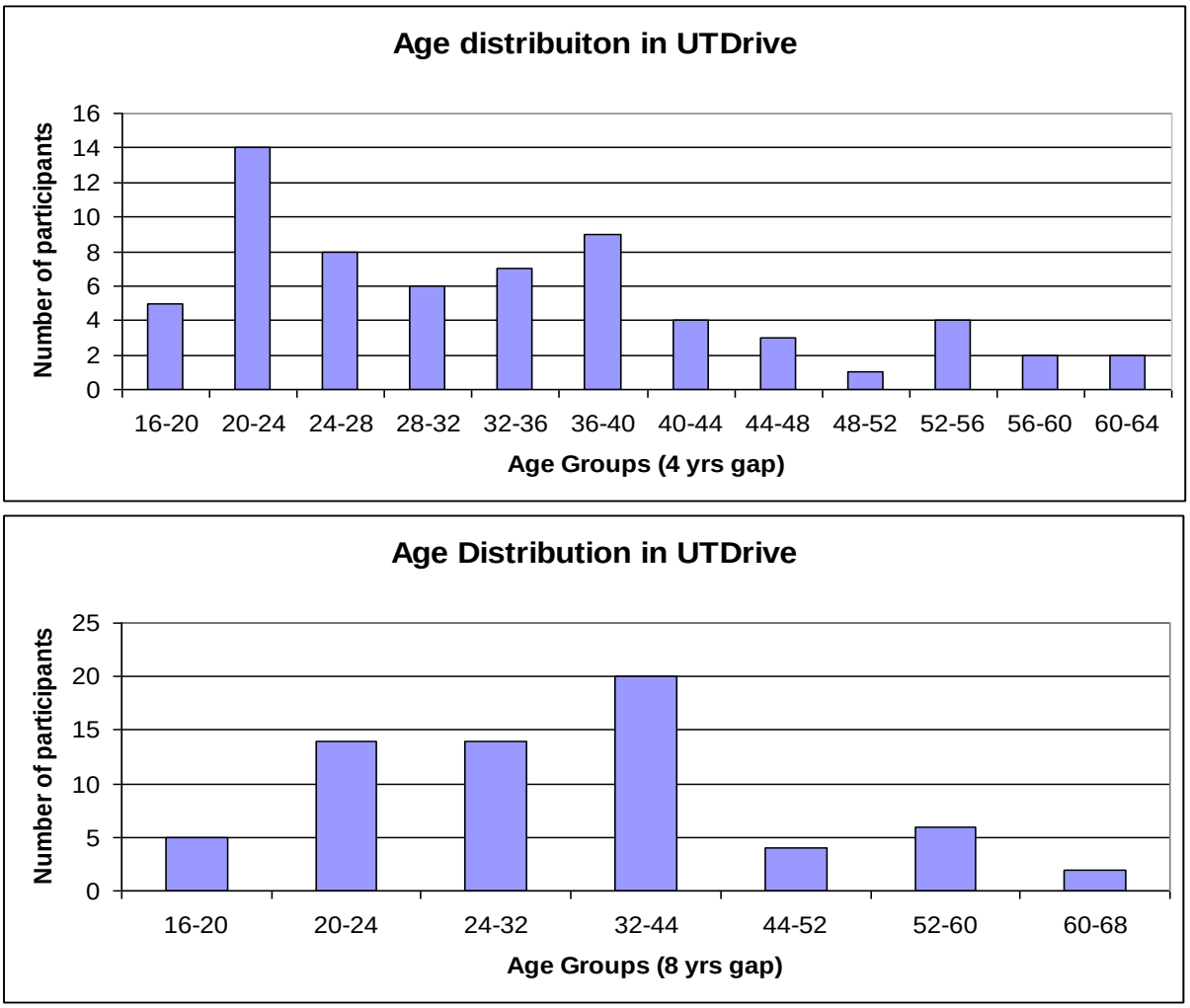


Figure 1. Age distribution in UTDrive (77 participants, 40M, 37F) in 4 and 8 year gaps

Gender Distribution

The gender is one of the important factors affecting driver behaviour. It is known that female drivers might be more cautious and have higher safety margins compared to male drivers. Therefore it is desired to have male and female drivers participating at the same rate to the experiments. Currently, UTDrive Corpus contains 40 M and 37 F participants. (Figure 2)

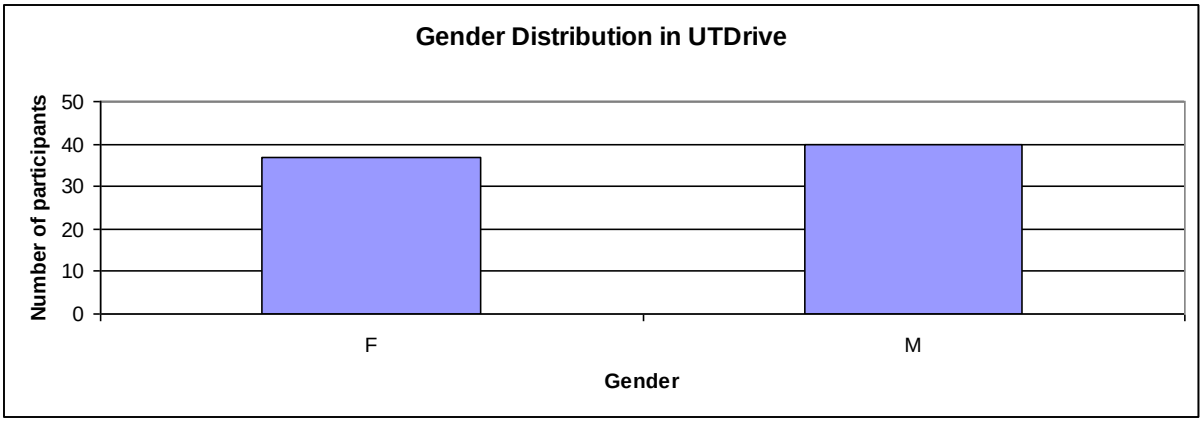


Figure 2. Gender distribution in UTDrive corpus: 37 F and 40 M.

Driving Experience Level

One of the most influential factors in driving behaviour is the experience level of the drivers. Novice drivers tend to be more cautious and nervous, i.e. having longer gap allowances in car following. The experienced drivers are more skilled in controlling the vehicle; they can utilize visual, proprioreceptive and tactile feedback while driving, however novice drivers highly depend on the visual input initially. These facts affect the way drivers control the car and to represent different skill levels corpus has a range of drivers with experience from 1 year to 50 years. (Figure 3 and 4)

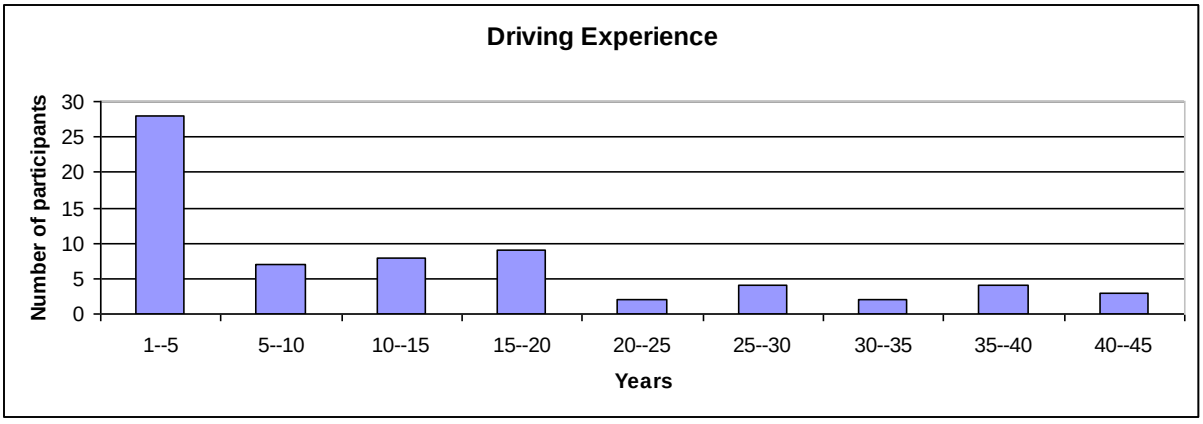


Figure 3. Driving experience distribution in UTDrive corpus with 5 year groups

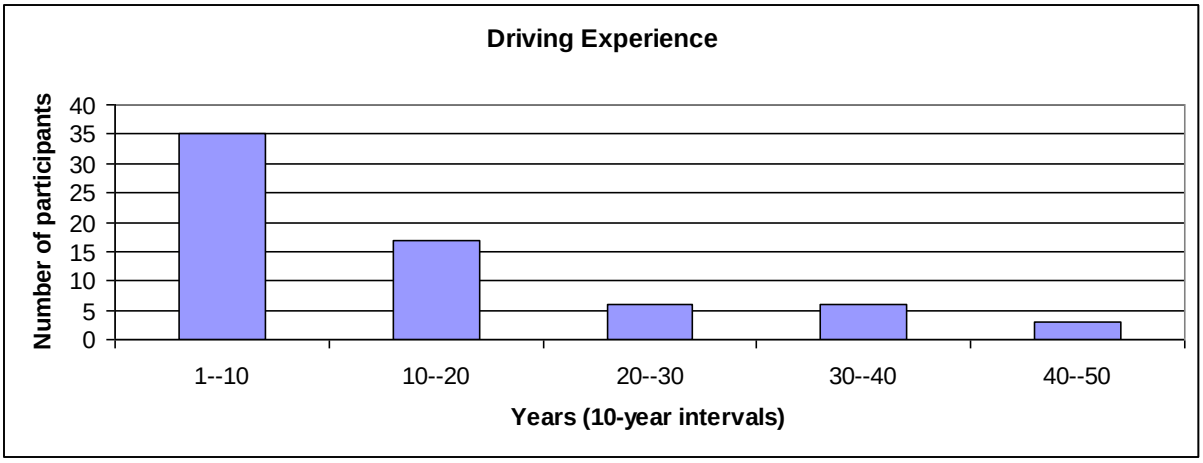


Figure 4. Driving experience distribution in UTDrive corpus with 10 year groups

Cell-phone Usage Frequency

For the particular aims of NEDO project, it is very important to examine the interaction of drivers with in-vehicle info-tech-entertainment devices and how the use of them affects the driver behaviour. The cell-phone is maybe the most frequently used device on cruise. Therefore, in the questionnaire, the participants are asked to score their cell-phone use frequency in a [1-5] scale (i.e. 1: seldom, 5: very often) while they are driving. (Figure 5)

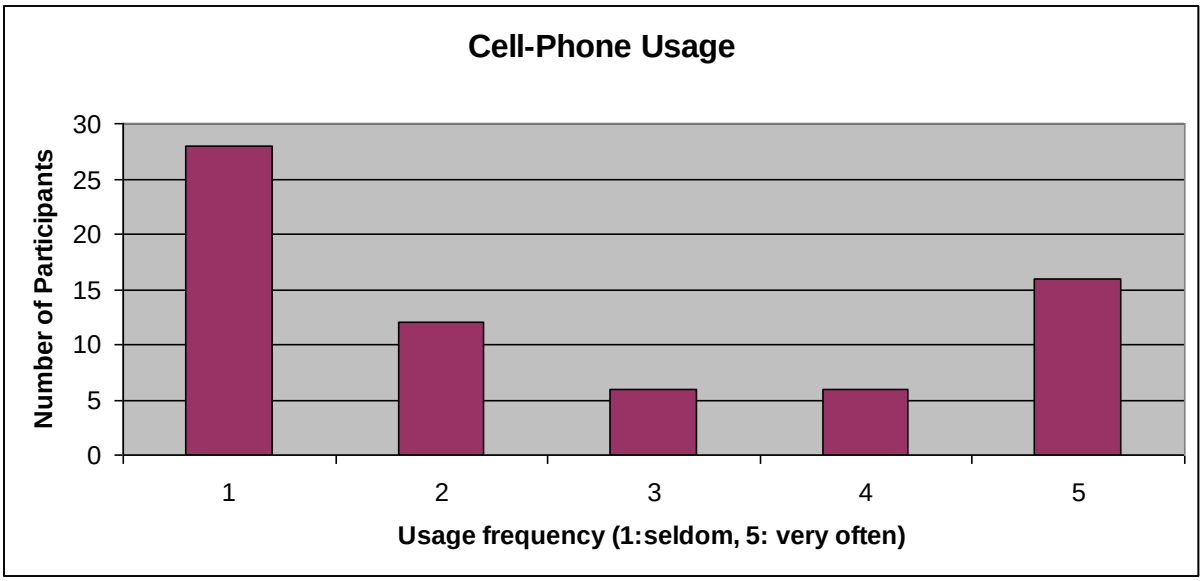
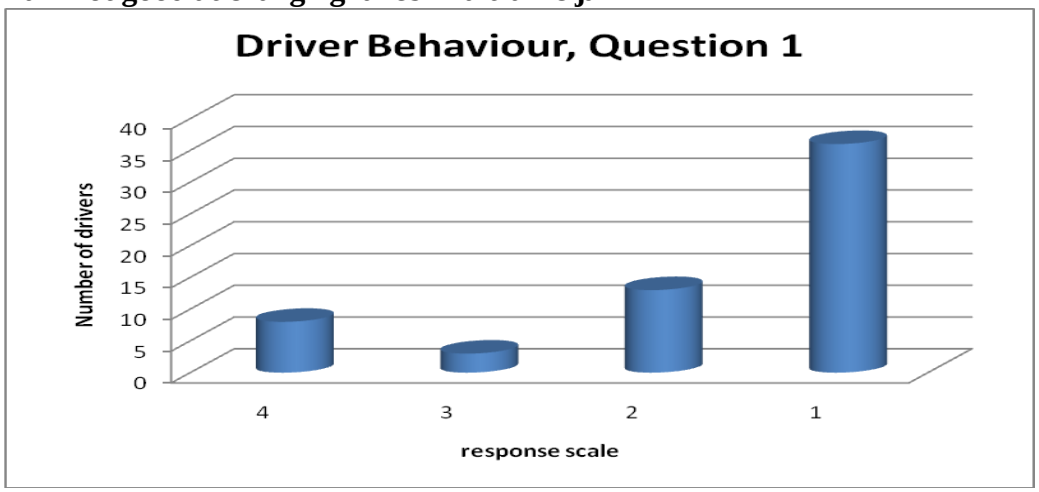


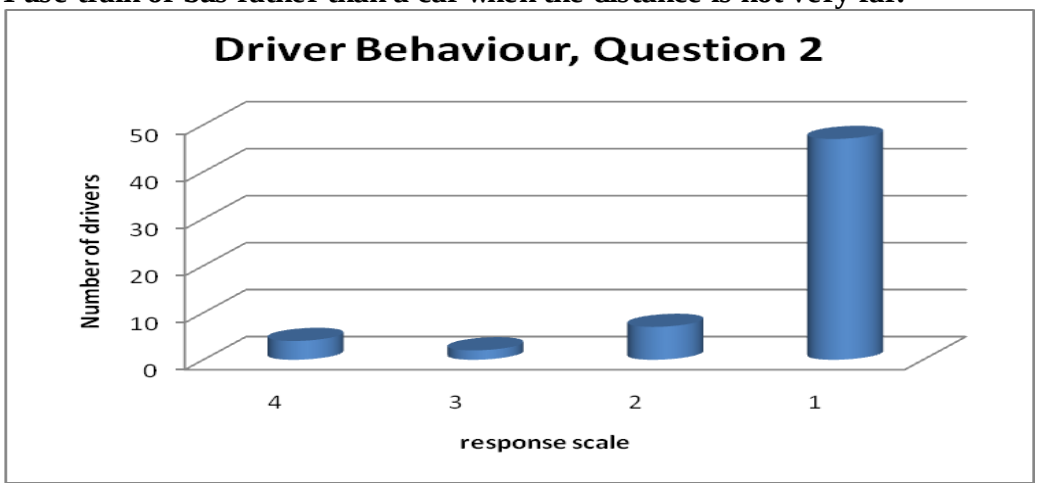
Figure 5. Cell-phone usage frequency 1: seldom, 5: very often

DRIVER BEHAVIOUR QUESTIONNAIRE RESULTS
(DRIVER SELF ASSESSMENT based on 77 drivers)
Response Scale: 4: True, 3: Mostly true, 2: Partially true, 1: Not true

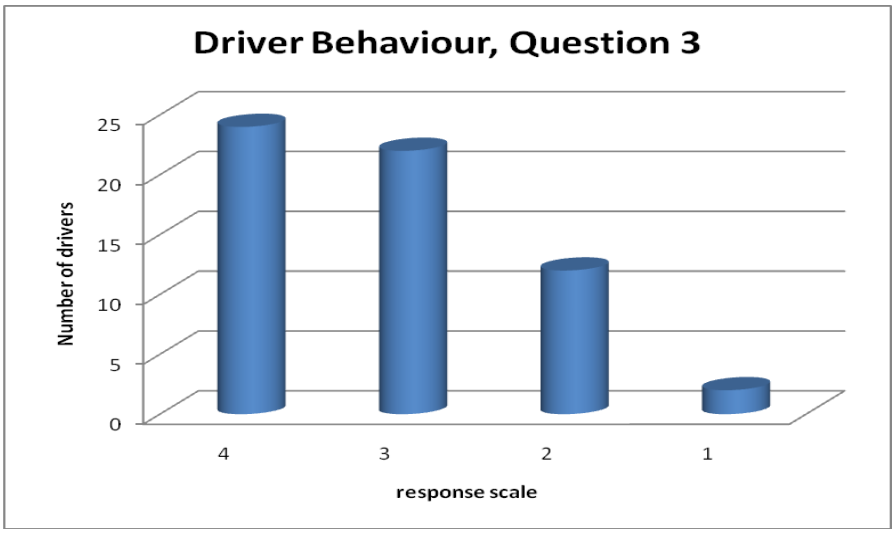
1. **I am not good at changing lanes in a traffic jam**



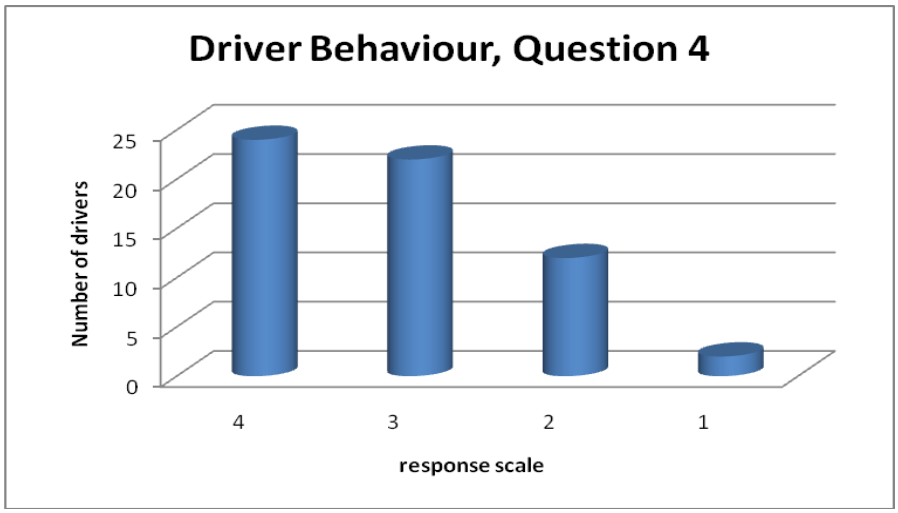
2. **I use train or bus rather than a car when the distance is not very far.**



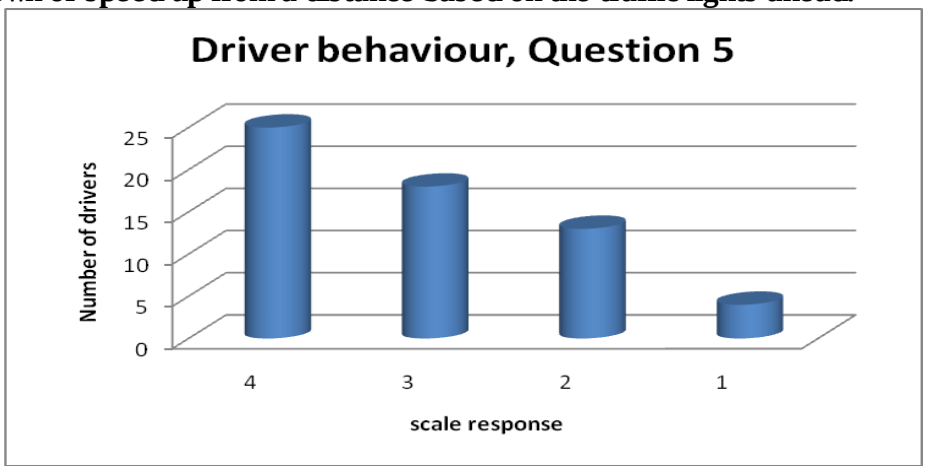
3. **I don't mind others cutting into the lane in front of my car. I keep distance from the car in front.**



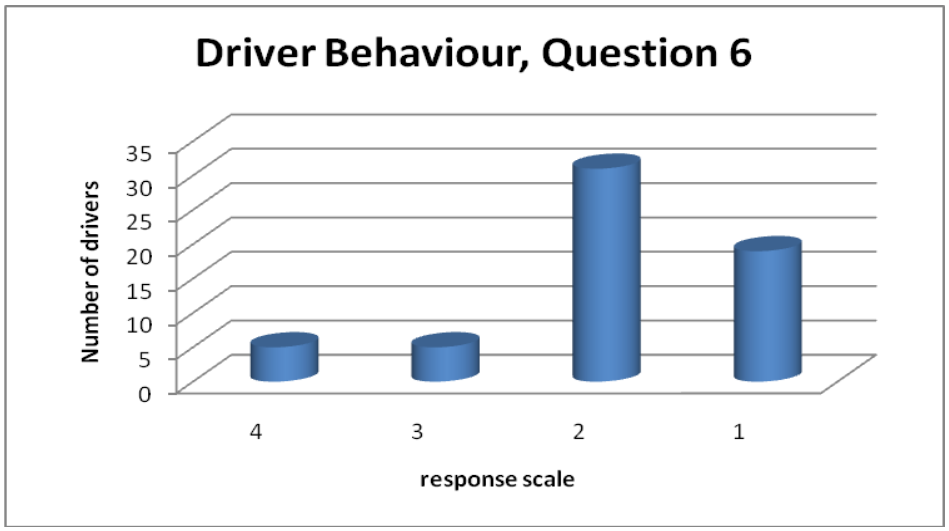
4. **I always follow signs that require me to slow down or stop**



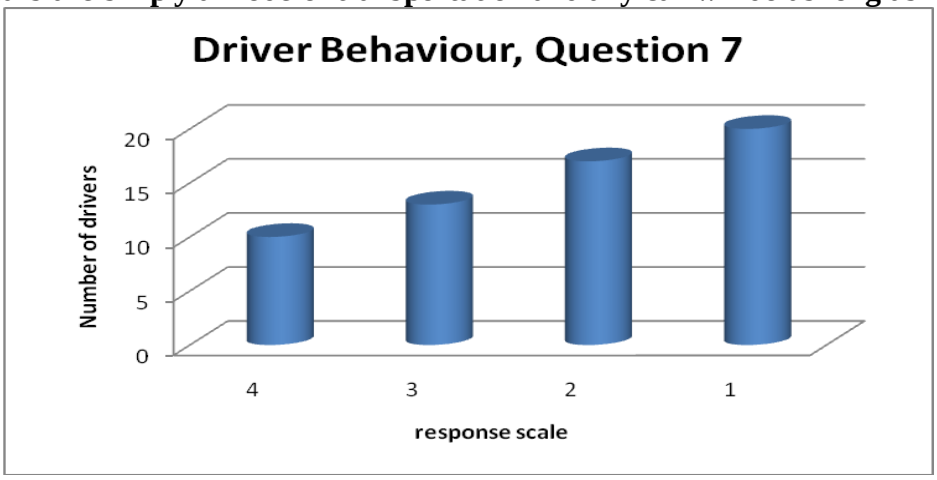
5. **I slow down or speed up from a distance based on the traffic lights ahead.**



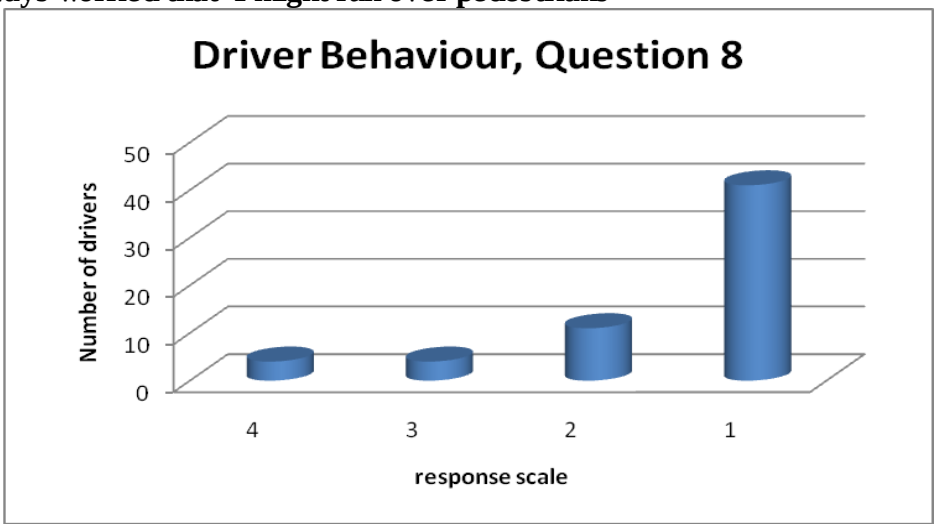
6. **When I have problems, I sometimes cannot concentrate on driving**



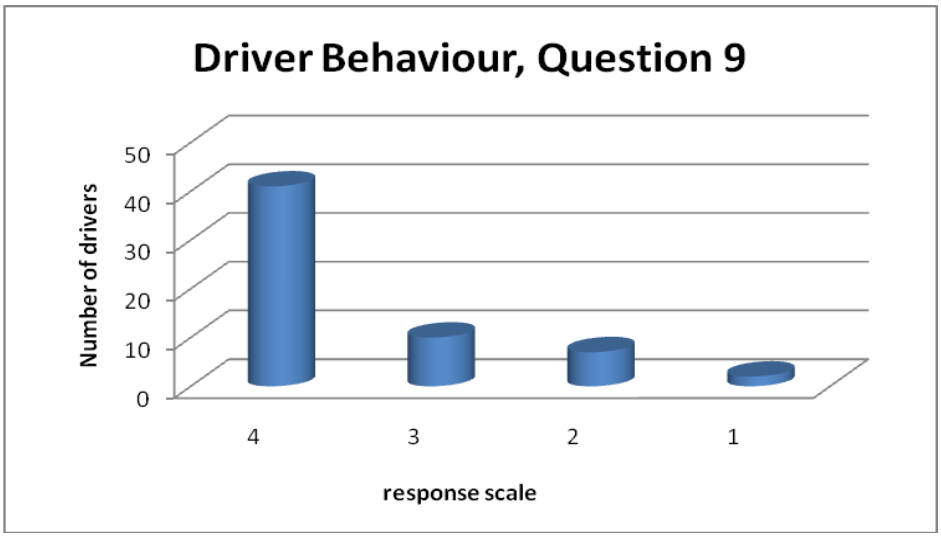
7. **I think cars are simply a mode of transportation and any car will do as long as it runs**



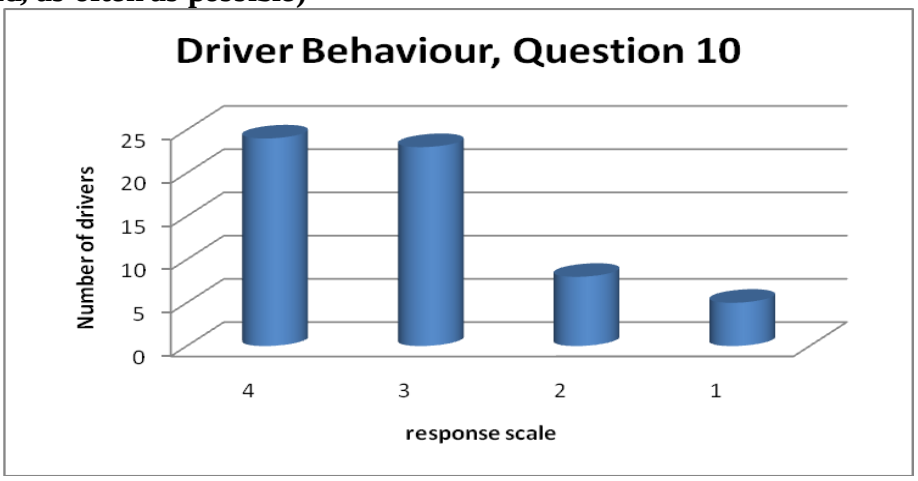
8. **I am always worried that I might run over pedestrians**



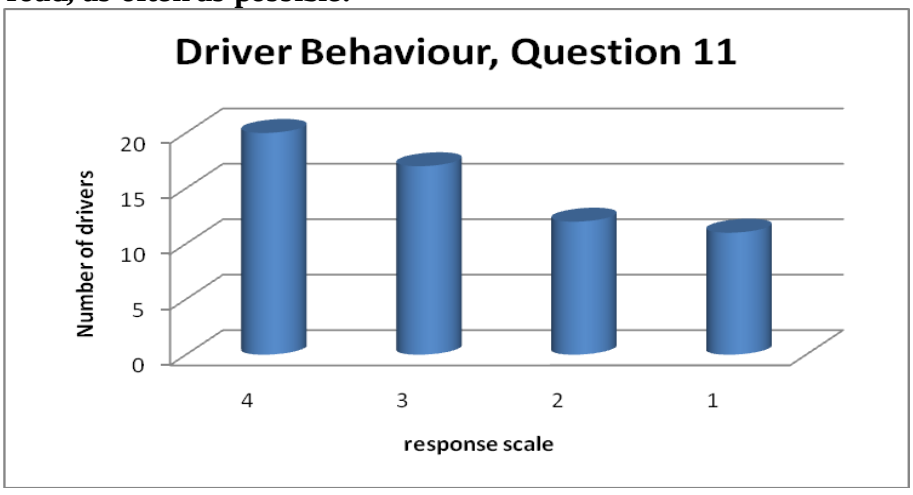
9. **I avoid parking in areas where parking is prohibited and/or restricted even it is a short time.**



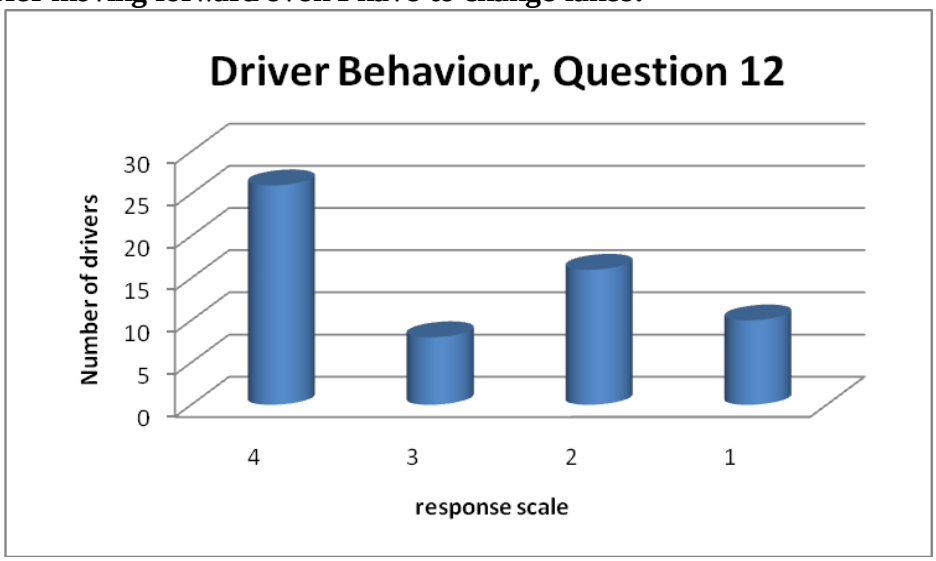
10. I am confident at estimating the dimensions of a vehicle (e.g. I can handle a car well, even when there is not plenty of space/width on the road with traffic lights instead of a small road, as often as possible)



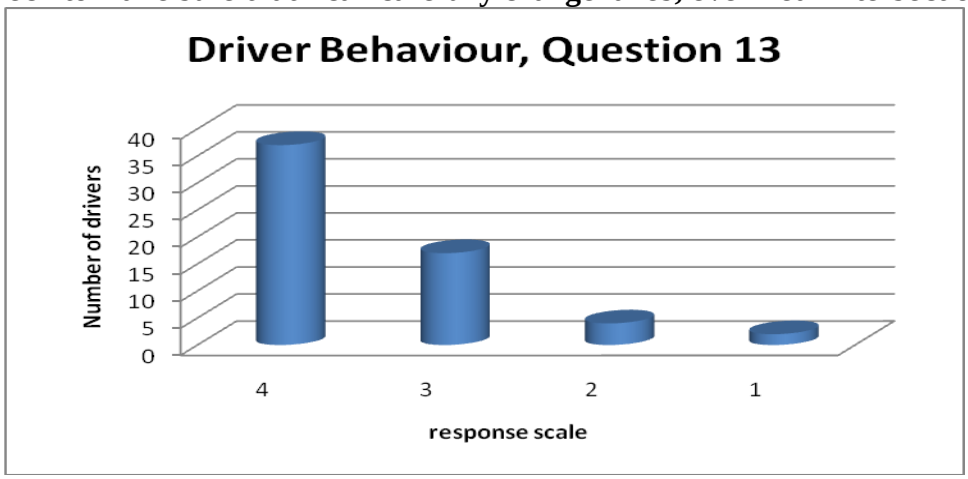
11. When I drive, I choose a wide and well maintained road with traffic lights instead of a small road, as often as possible.



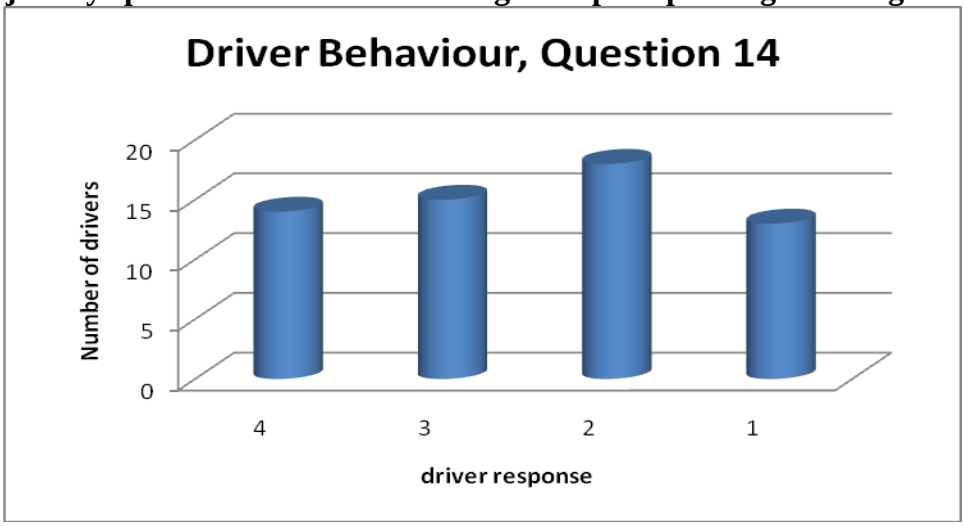
12. I prefer moving forward even I have to change lanes.



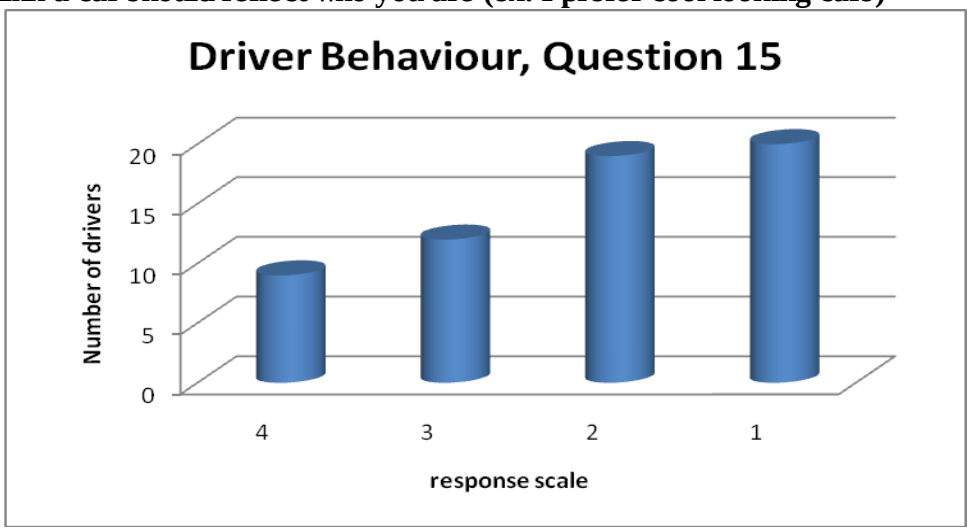
13. I check to make sure that I can carefully change lanes, even near intersections



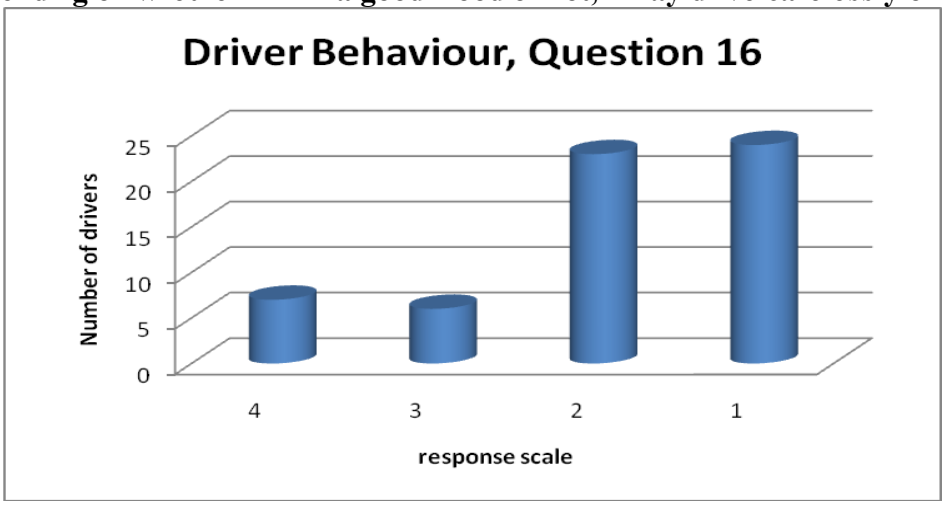
14. I adjust my speed in order to avoid having to stop at upcoming traffic lights.



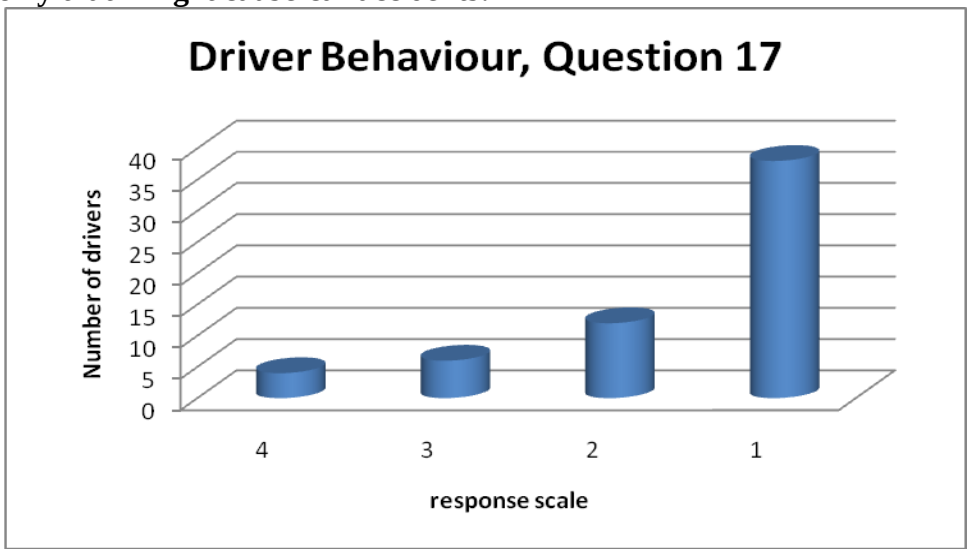
15. I think a car should reflect who you are (ex. I prefer cool looking cars)



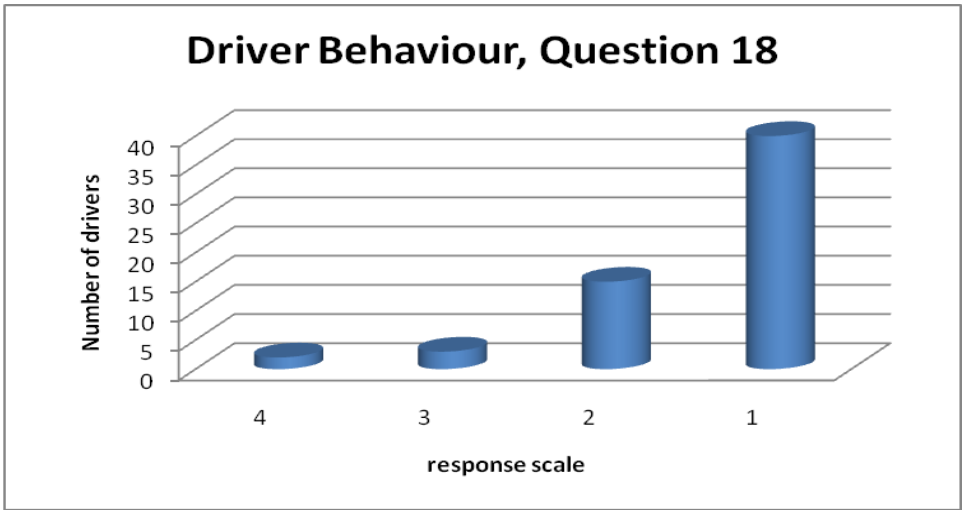
16. Depending on whether I'm in a good mood or not, I may drive carelessly or fast.



17. I worry that I might cause car accidents.



18. I always drive below the speed limit.



SPEAKER/DRIVER SURVEY FORM on STRESS LEVEL DURING DRIVING

Response Scale:

1: I will drive normally
2: I will drive carefully, but it is not stressful for me
3: I would feel a little stressed to drive under this condition
4: I would feel nervous and stressed, it would be a lot of stress for me
5: It is too stressful for me, I would not want to drive under this condition.

Questions

1. **Driving where there are many unexpected movements, such as bicycles going between cars and suddenly coming out from the crossing street.**
2. **Driving at night where brightness changes because of a varying number of street lights.**
3. **Driving while feeling upset due to reasons that are not related to driving.**
4. **Driving late at night.**
5. **Driving in a traffic jam where there is no way out.**
6. **Driving while feeling pain, stiffness, or numbness in the legs, hips or back due to the driving conditions.**
7. **Driving while looking for routes or destination using the road signs or map.**
8. **Driving when it is too cold, such as when the air conditioning is too strong in the summer, or takes time before the car starts warming up in the winter.**
9. **Driving on a mountain road or wilding road which requires more attention to steering and acceleration.**
10. **Driving in a seat that is soft and does not fit with your body.**
11. **Driving on a road in which many cars are parked.**
12. **Driving when it is difficult to see the road and the surroundings due to the direct sunlight from sunset or sunrise.**
13. **Driving with passengers**
14. **Driving when your daily life is out of balance**

15. **Driving at a speed slower than what would you like, such as the speed limit being too low for you.**
16. **Driving for a long time without getting out of the vehicle often.**
17. **Driving when you are not sure of where you are driving due to reasons such as you are not familiar with the roads in the area.**
18. **Driving when it is hot in the vehicle due to direct sunlight, etc.**
19. **Driving with careful steering on narrow roads continuously.**
20. **Driving in a seat whose shape does not fit your body**
21. **Driving on a road which has many stops (such as crossings) and you have to make sure that the road is clear every time.**
22. **Driving on a road whose pattern/shape change frequently. For example, a road that is a mixture of straight, turns, merging and splitting, such as highways in big cities.**
23. **Driving with people who might make you nervous, such as your boss, teacher, etc.**
24. **Driving when you feel sick (illness such as cold or headache)**
25. **In traffic jam, driving with frequent braking and accelerating**
26. **Driving drowsy due to lack of rest**
27. **Driving when the road signs to the destination are difficult to understand**
28. **Driving when the air in the vehicle is not clean due to dust, exhaust, etc.**
29. **Driving when you are not comfortable with how the control of pedal feels, such as accelerating or breaking.**
30. **Driving when you are not comfortable with the positions of the seat, wheel or pedal**
31. **Driving when you are not used to dimensions of the vehicle (e.g. driving a large SUV in a city for the first time)**
32. **Driving on a road whose lane structures are complicated, such as multiple lanes for left turn only and right turn only, or your lane being irregular mixture of left turn lane, right turn lane and straight lane.**
33. **Driving when you are carrying items that are fragile, unstable or expensive which requires extra care.**
34. **Driving after psychologically stressful work**
35. **Driving while you are not sure of when you will reach your destination**
36. **Driving when the noise level or vibration level (up and down) in the vehicle is high**
37. **Driving when you cannot see the environment (forward or around) well due to conditions such as luggage, people in the vehicle, windows being dirty**
38. **Driving when it is raining.**

OBSERVATIONS and ANALYSIS

As seen from Table 1, the cumulative results on perceived stress level under different conditions described by questions 1-38 are given. The response scales 3, 4 and 5 stand for increasing stress levels respectively, whereas 1 and 2 indicates no stress or manageable stress situations. Taking only responses with 3, 4 and 5 for each question the most stressful situations are identified based on 77 drivers (40 male, 37 female)

(Figure 1). According to this figure, the most stressful situations are addressed by questions 5, 6, 7, 12, 24, 27 and 37, corresponding to traffic jam, driving while feeling pain and stiffness, managing navigation (map/road signs), visibility of the road due to illumination, driving while being sick, driving when the road signs are difficult to understand and driving with poor visibility due to occlusion inside the vehicle. Amongst the situations inducing stress the least stressful events are 4, 8, 11, 13 and 38; corresponding to driving at night, driving when it is too cold, driving where a lot of cars are parked and driving when it is raining. The manageable stressful situations are plotted in Figure 2, counting only responses with 1 and 2. Finally the least stressful situations are plotted counting only the responses with level 1 in Figure 3 being the temperature and driving with passengers.

Table 1. Cumulative Results for Speaker/ Driver Stress Level Survey

CUMULATIVE SPEAKER/DRIVER STRESS SURVEY RESULTS					
	Response Scale				
Question Number	**1**	**2**	**3**	**4**	**5**
1	5	30	17	6	2
2	15	29	11	5	0
3	12	18	25	4	1
4	22	29	6	3	0
5	9	17	24	7	3
6	3	14	25	14	4
7	6	19	25	10	0
8	29	23	8	0	0
9	4	30	14	10	2
10	17	22	18	2	1
11	17	35	7	1	0
12	1	30	20	8	1
13	39	18	3	0	0
14	17	24	18	1	0
15	27	18	11	4	0
16	24	16	14	5	1
17	8	20	25	5	2
18	23	18	15	1	3
19	4	34	14	6	2
20	19	22	14	2	3
21	21	23	12	2	2
22	10	26	17	5	2
23	7	30	16	5	2
24	9	21	23	3	4
25	14	22	18	4	2
26	2	21	19	11	7

27	4	15	28	9	4
28	12	15	22	7	4
29	2	27	19	8	4
30	6	25	18	7	4
31	7	30	15	6	2
32	7	26	20	5	2
33	5	31	19	3	2
34	7	26	21	3	3
35	15	18	23	2	2
36	12	16	25	4	3
37	2	17	24	11	6
38	13	30	12	3	2

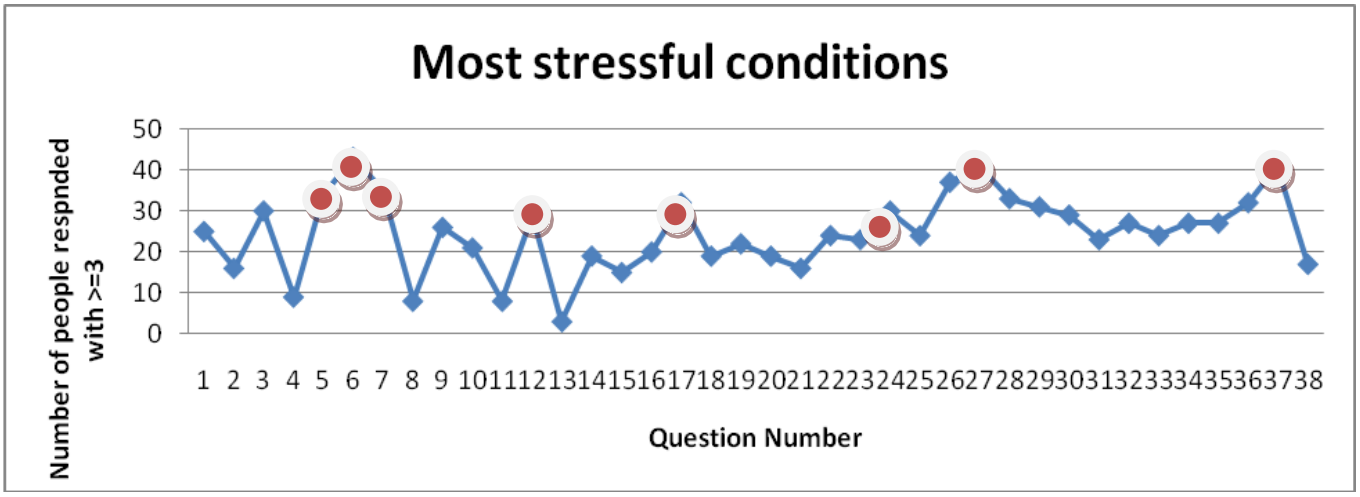


Figure 1. The most stressful situations

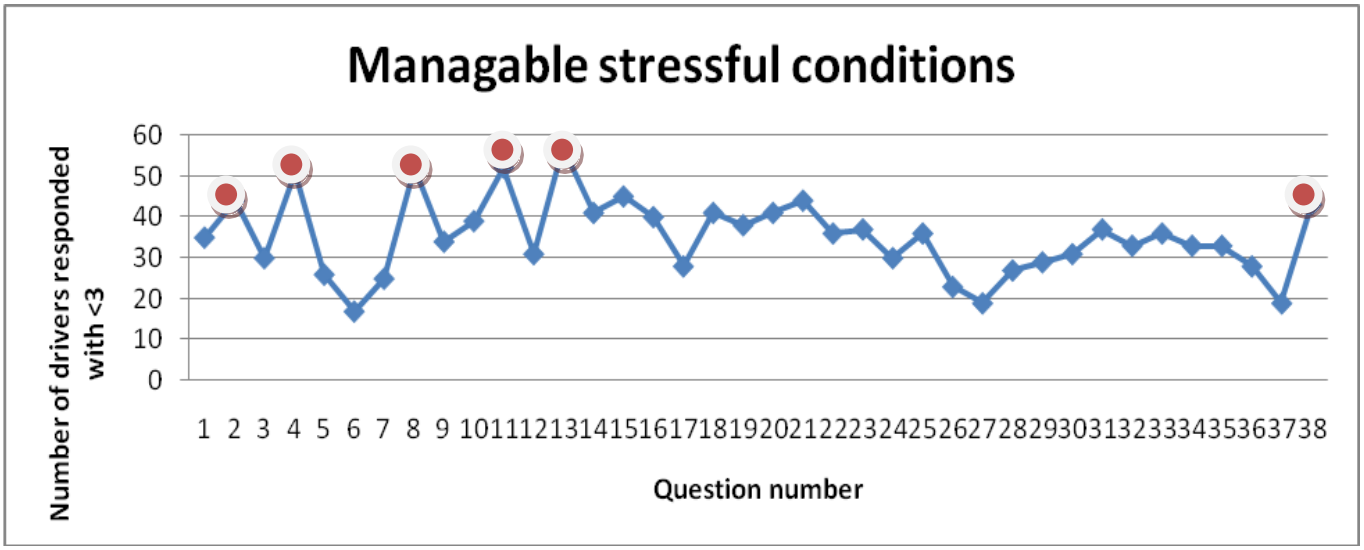


Figure 2. The managable stressful situations

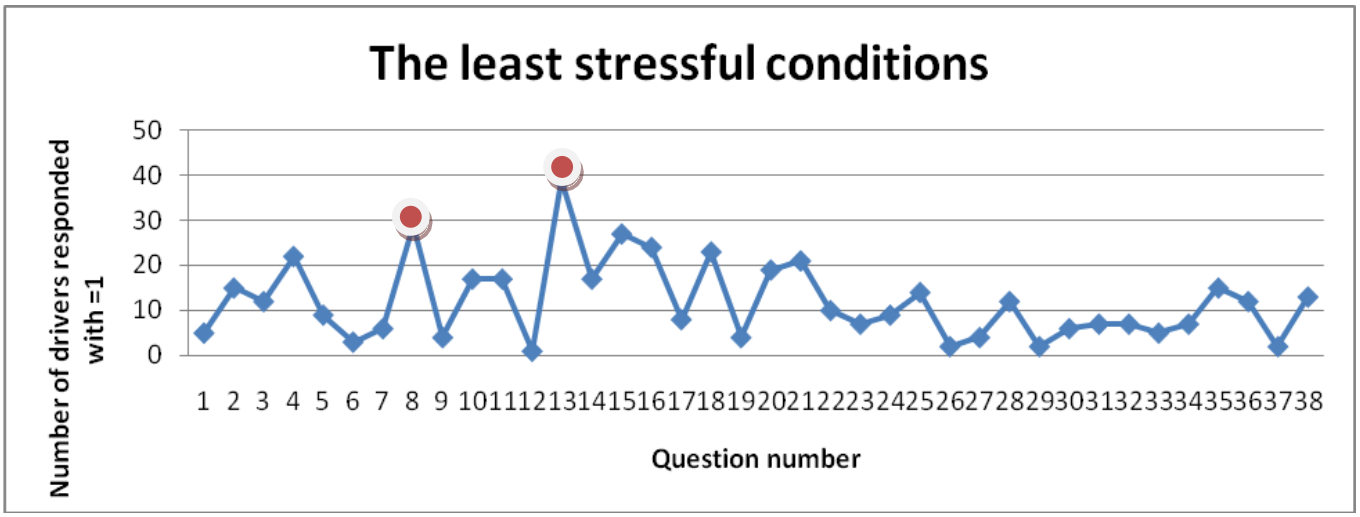
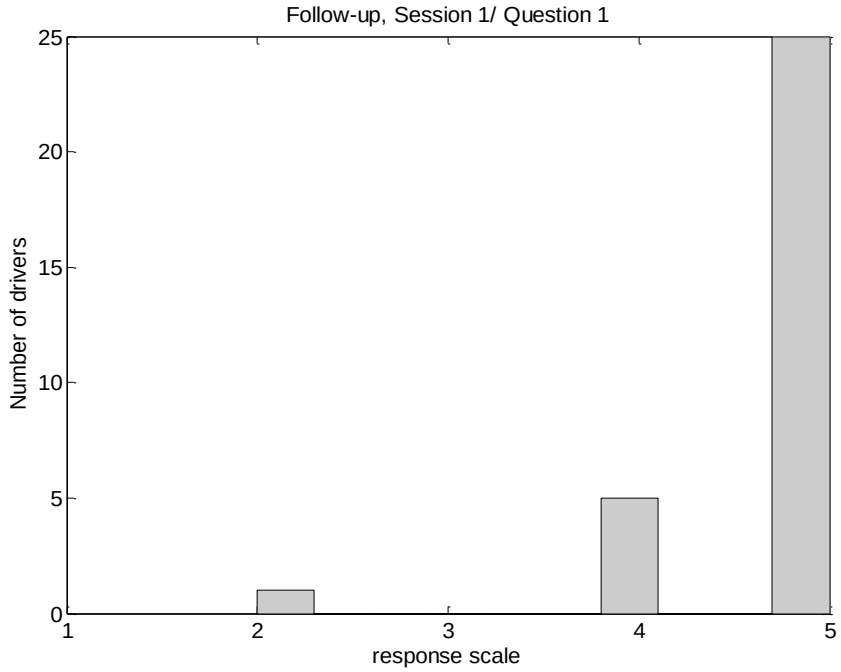


Figure 3. The least stressful conditions: 8 and 13; temperature and driving with passengers

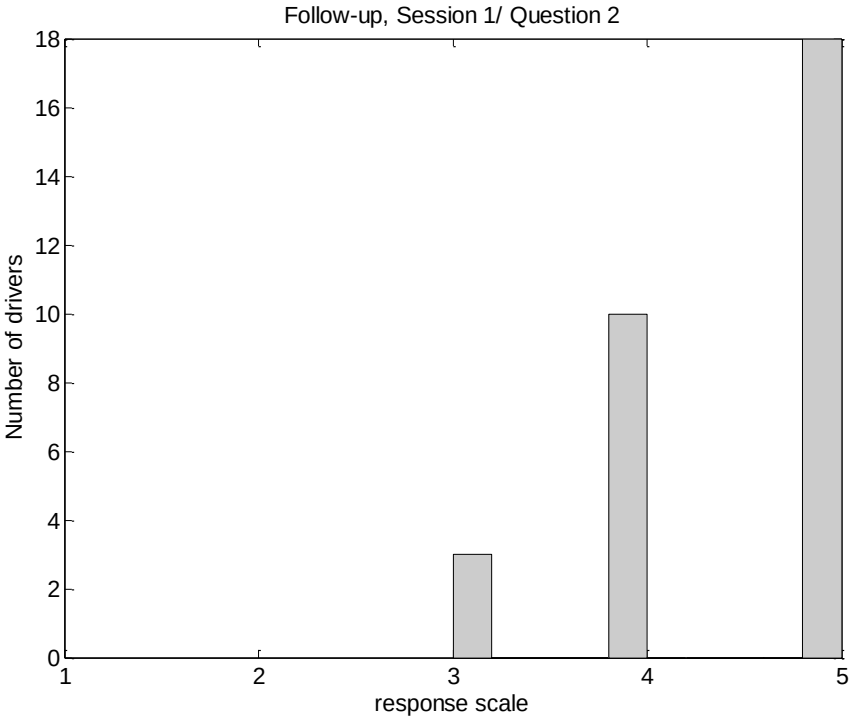
Follow-up Questionnaire Histograms

Session 1

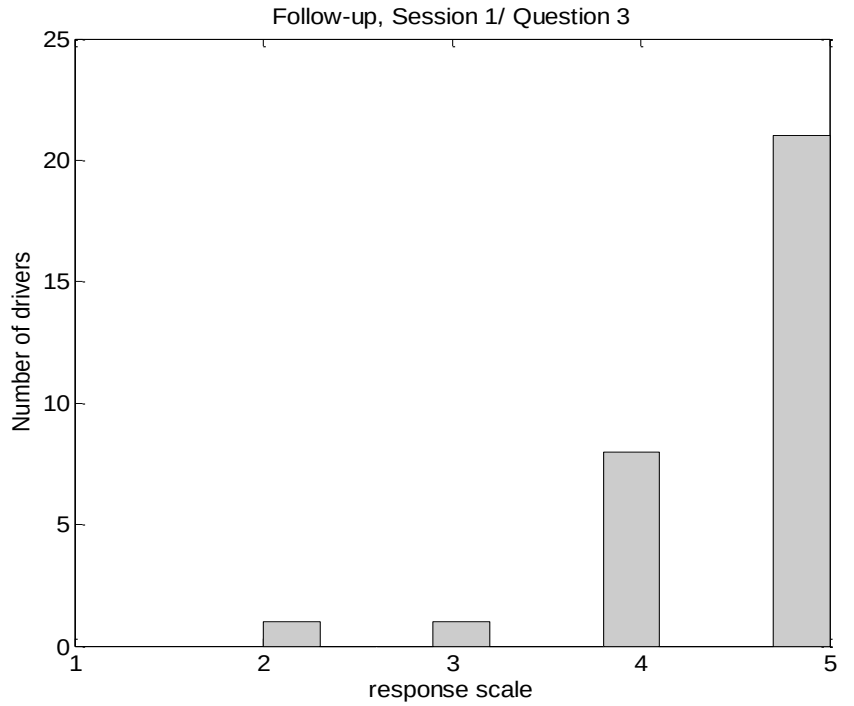
Question 1: Is your voice different from normal today? Scale: 1: Sore throat/Cold, 5: Normal



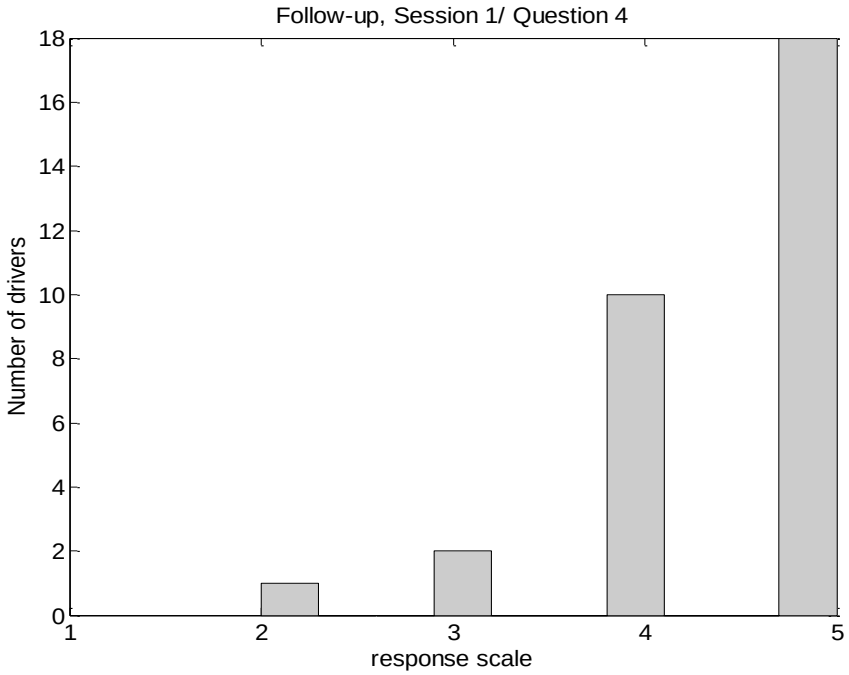
Question 2: How comfortable were you when you drove our car? Scale: 1: Uncomfortable, 5: Comfortable



Question 3: How comfortable were you in following this route? Scale: 1: Uncomfortable, 5: Comfortable

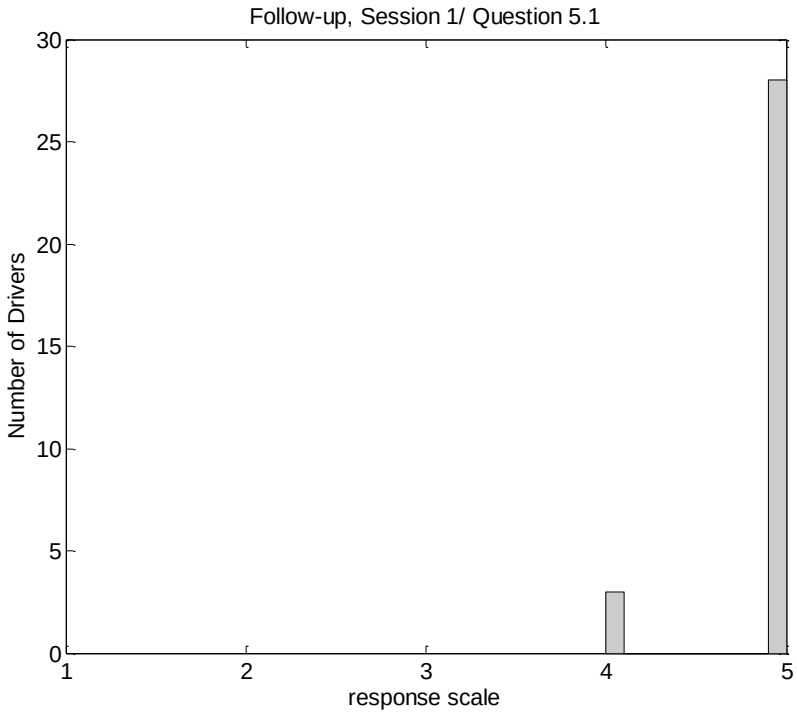


Question 4: Do you think your driving today is representative of your normal driver behaviour? Scale: 1: Pretty much, 5: Not at all

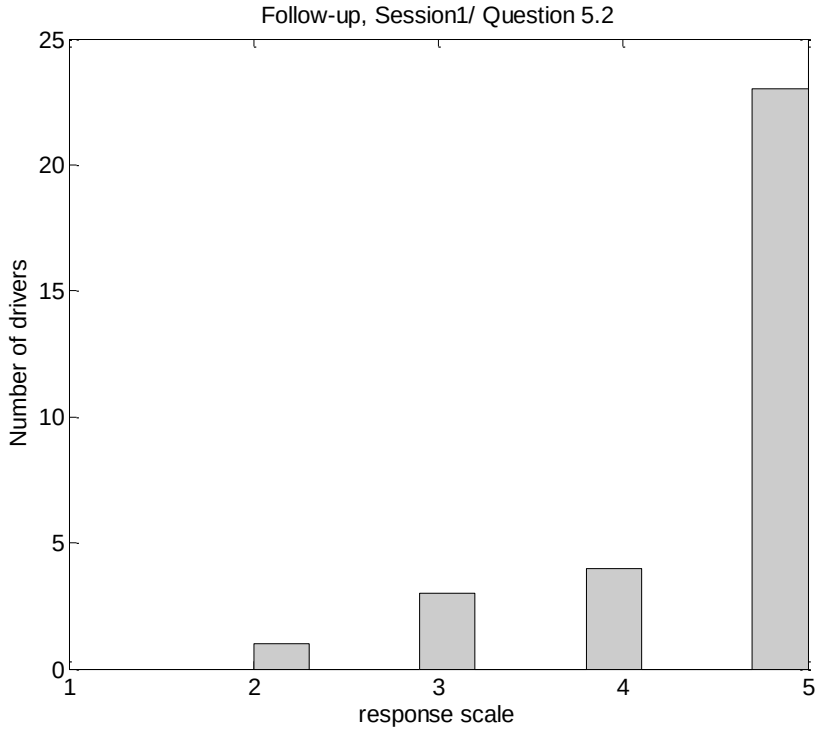


Question 5:Did you feel calm while you perform the following tasks? 1: Worried/stressful, 5: Calm

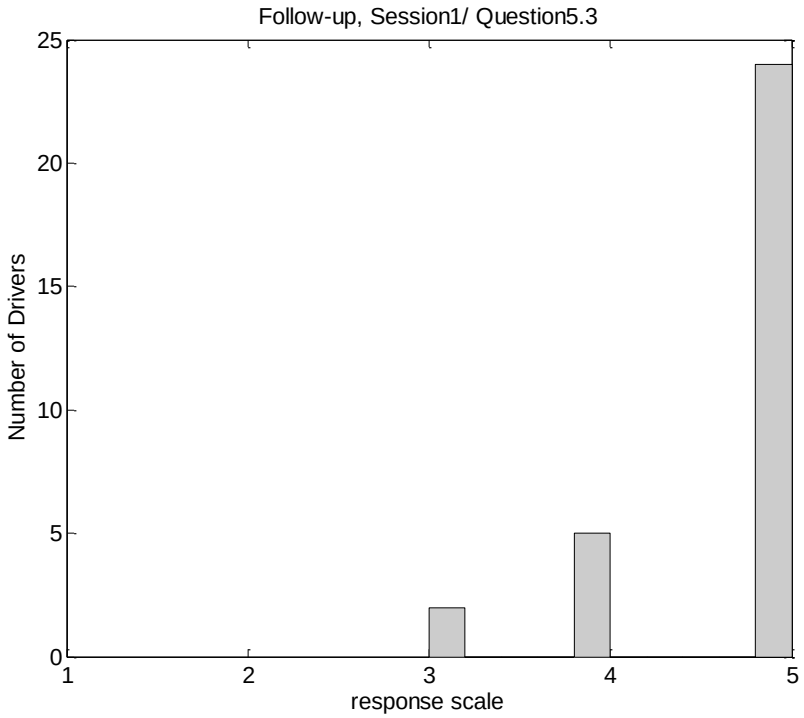
5.1: Driving under normal condition



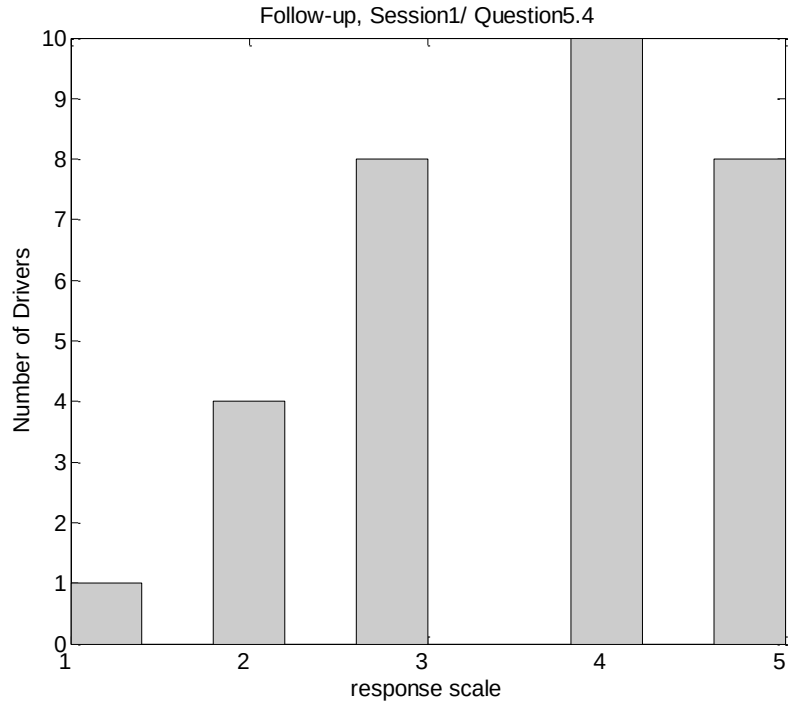
5.2. Driving while reporting road/navigation conditions



5.3. Driving while communicating with monitoring staff:



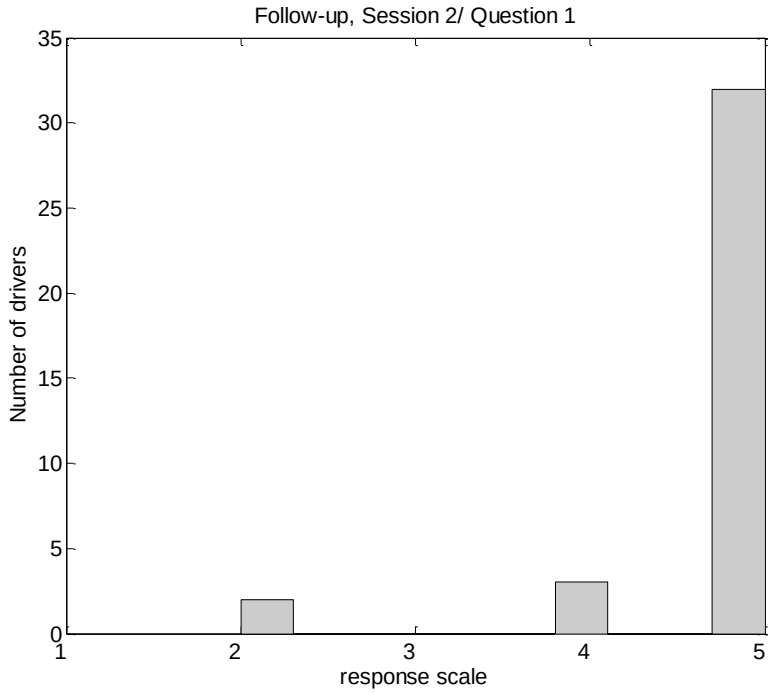
5.4: Driving while interacting with human-machine dialog system



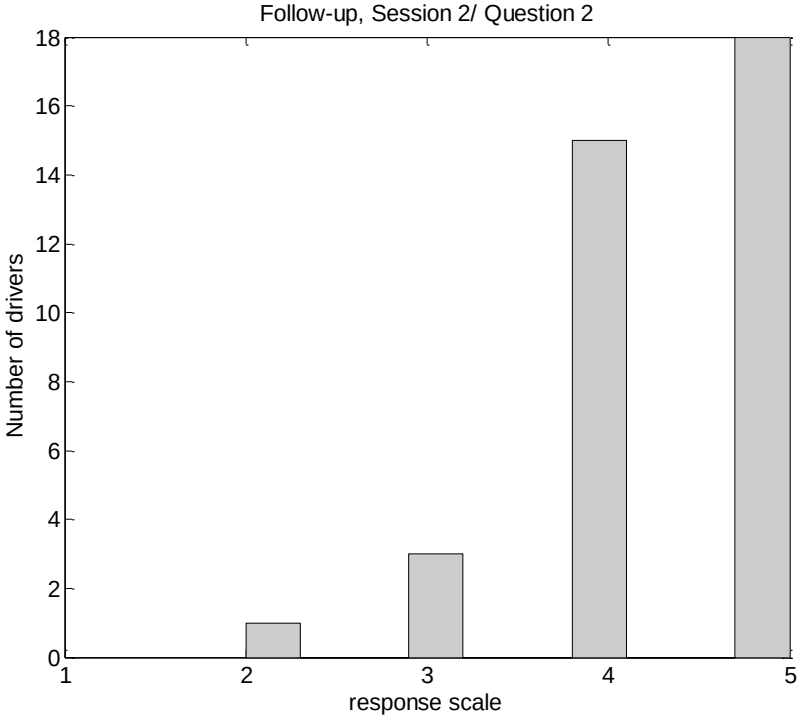
5.5. Driving while performing the other secondary tasks (e.g. radio tuning)

Session 2

Question 1: Is your voice different from normal today? Scale: 1: Sore throat/Cold, 5: Normal

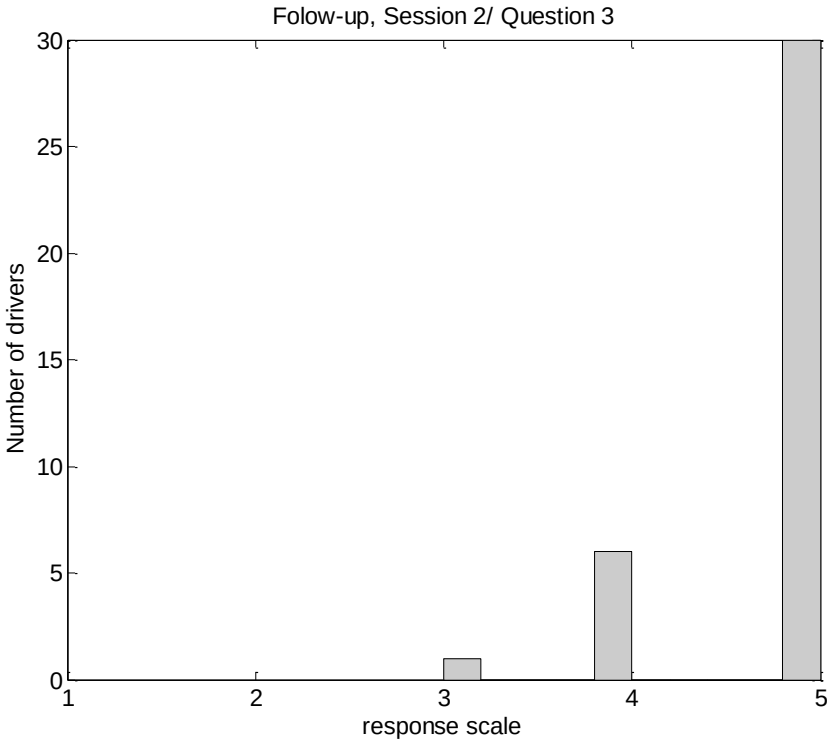


Question 2: How comfortable were you when you drove our car? Scale: 1: Uncomfortable, 5: Comfortable

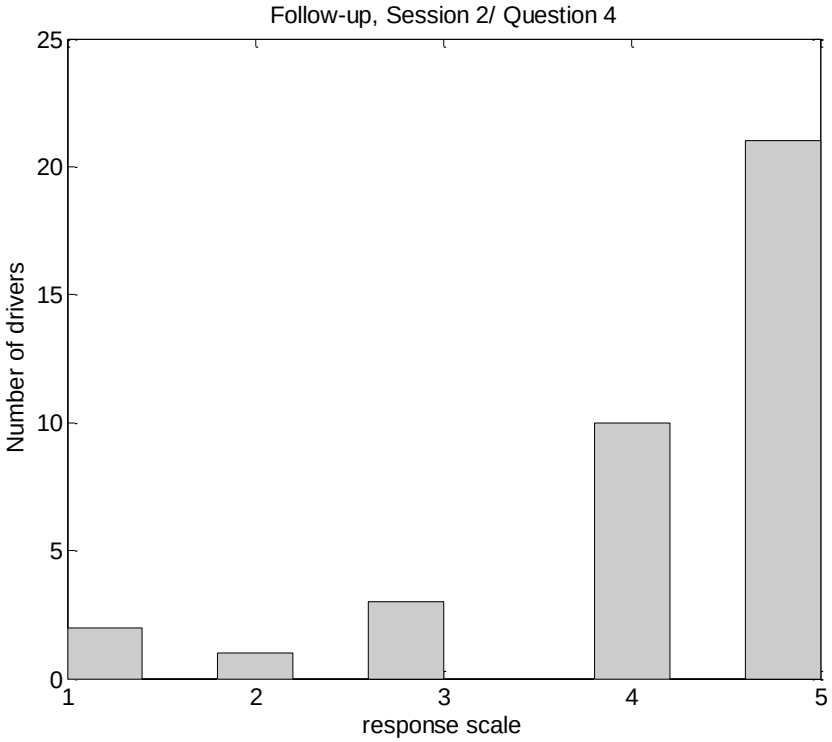


Question 3: How comfortable were you in following this route? Scale: 1: Uncomfortable, 5:

Comfortable



Question 4: Do you think your driving today is representative of your normal driver behaviour? Scale: 1: Pretty much, 5: Not at all



Question 5:Did you feel calm while you perform the following tasks? 1: Worried/stressful, 5:

Calm

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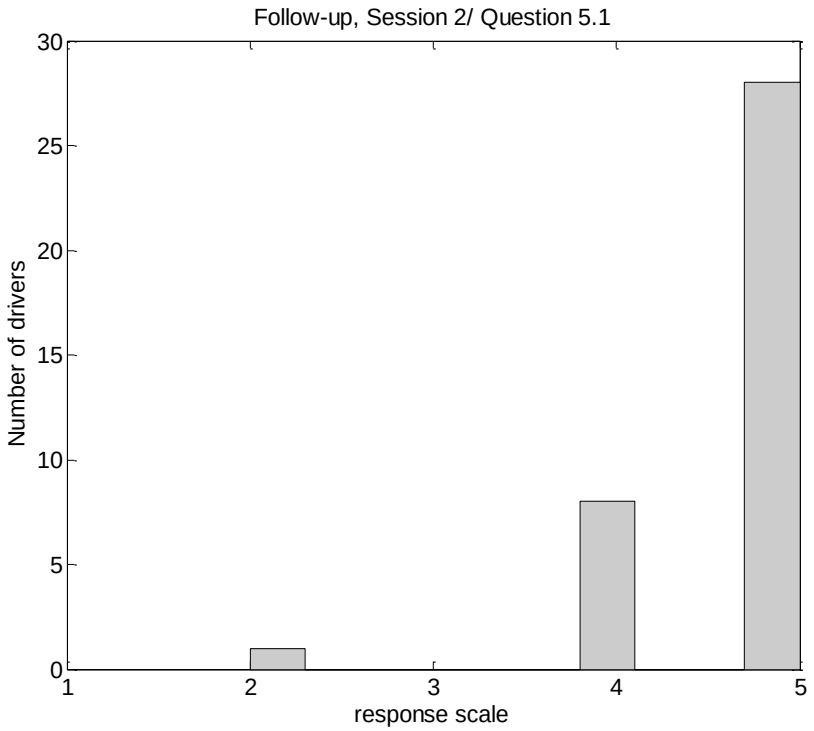
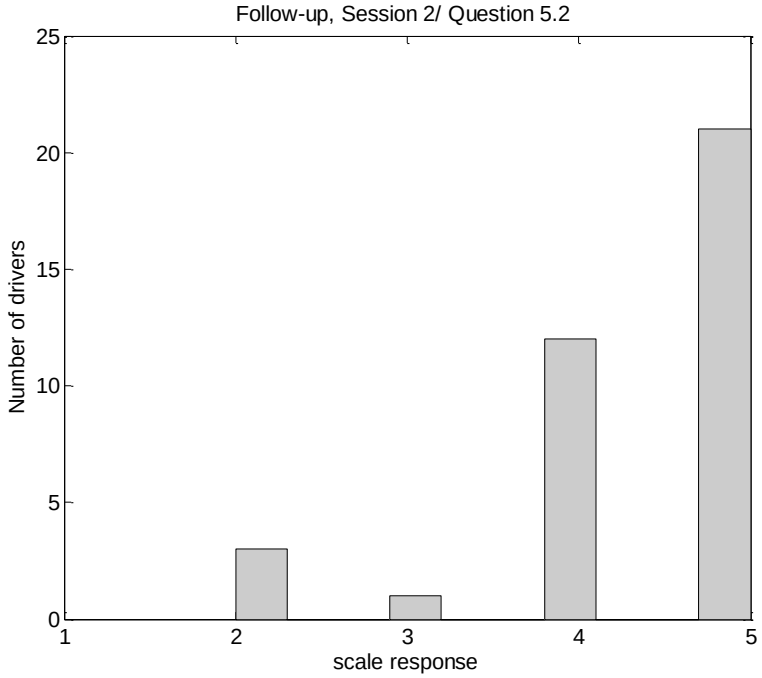
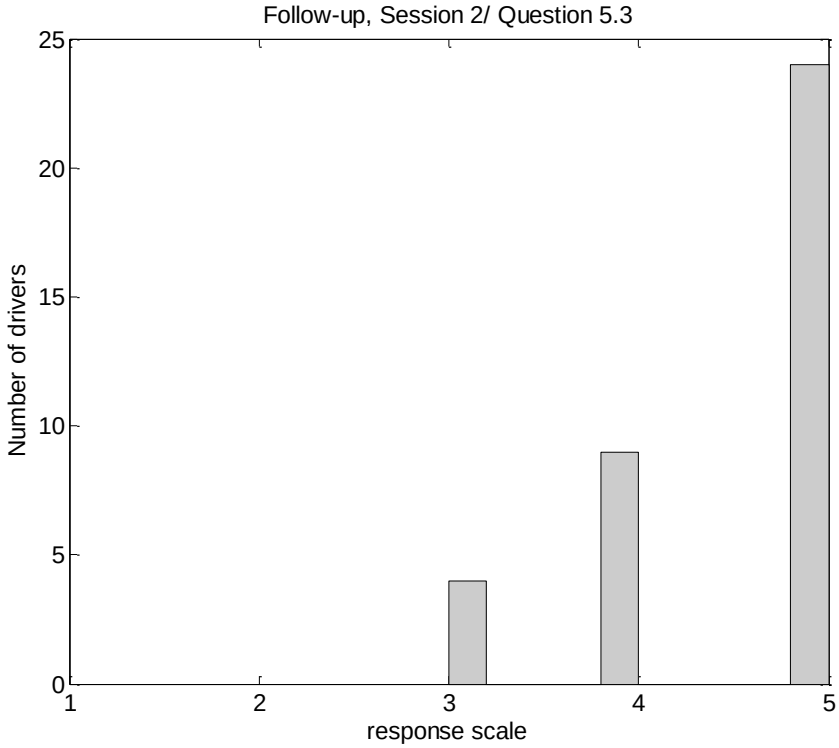


5.2. Driving while reporting road/navigation conditions



5.3. Driving while communicating with monitoring staff:



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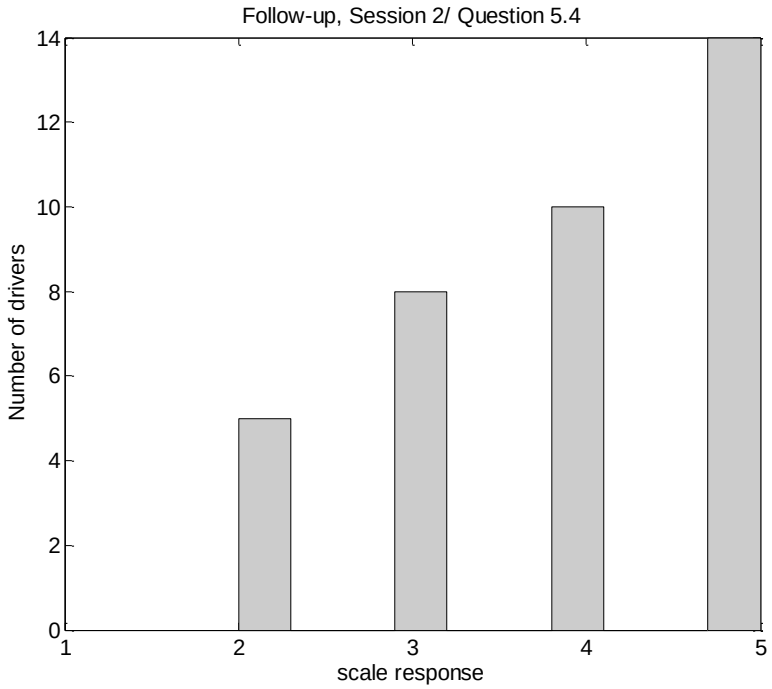
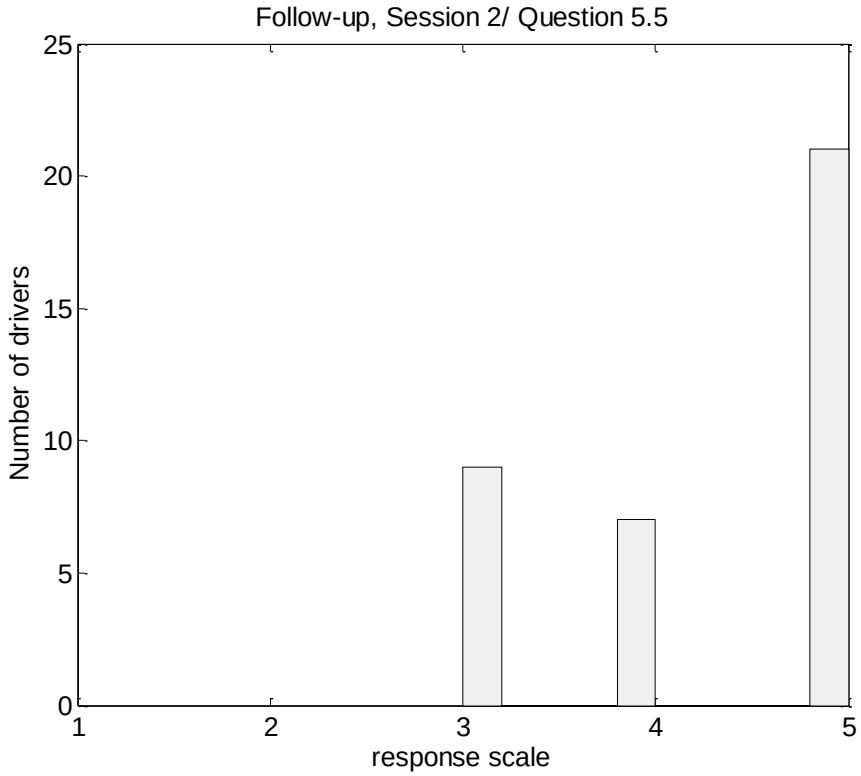
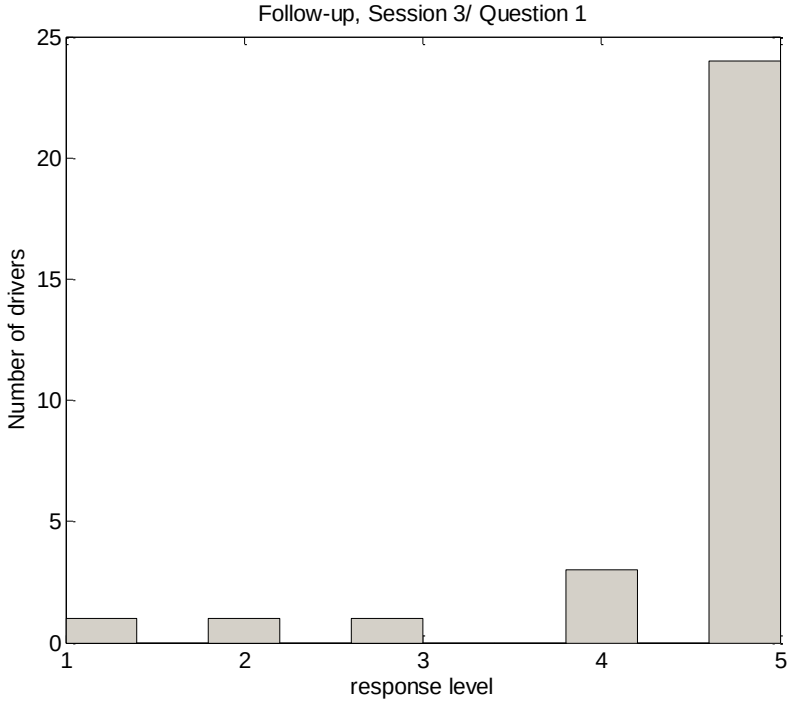


5.5. Driving while performing the other secondary tasks (e.g. radio tuning)

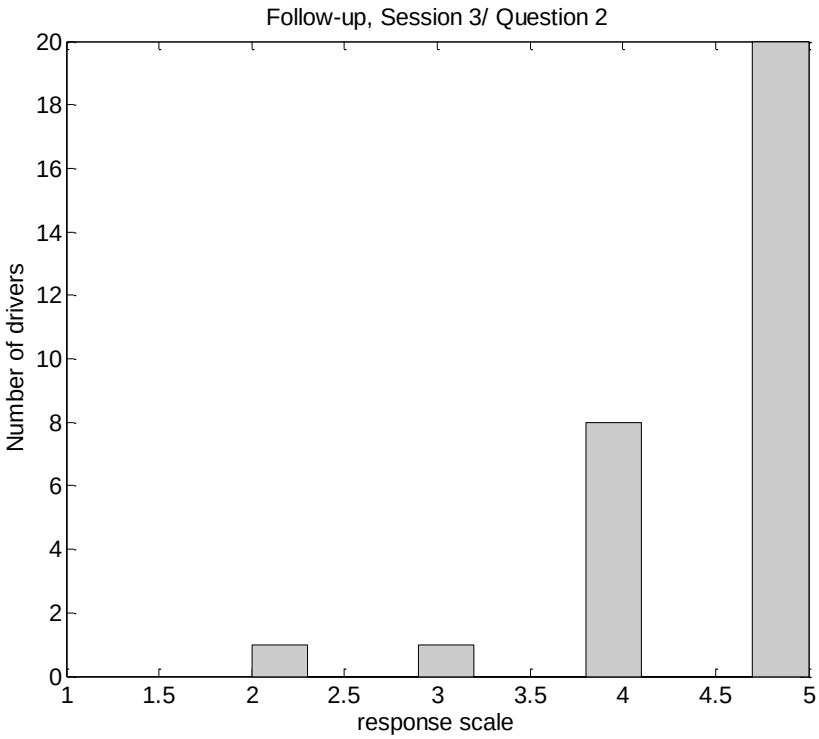


Session 3

Question 1: Is your voice different from normal today? Scale: 1: Sore throat/Cold, 5: Normal

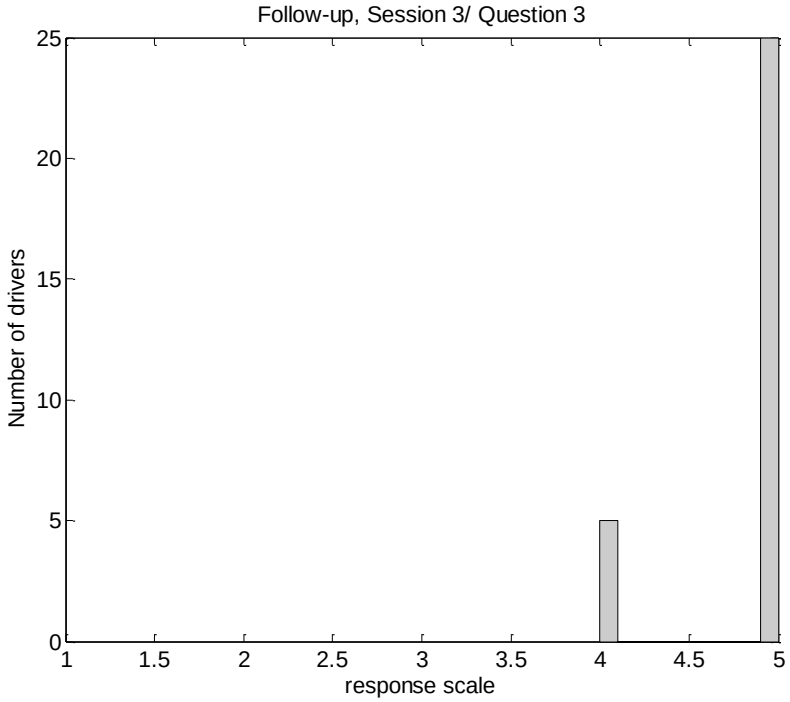


Question 2: How comfortable were you when you drove our car? Scale: 1: Uncomfortable, 5: Comfortable

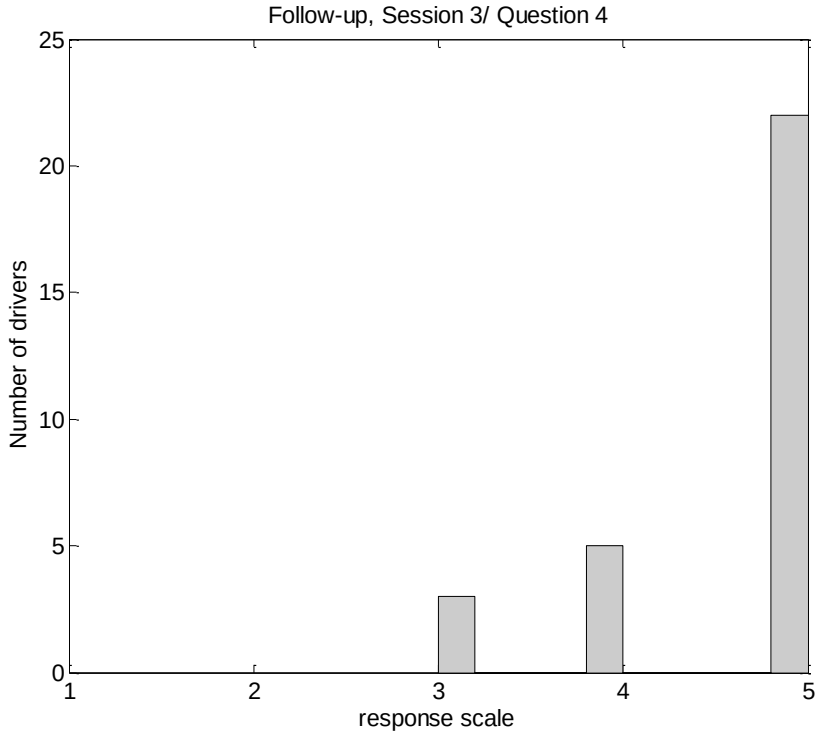


\

Question 3: How comfortable were you in following this route? Scale: 1: Uncomfortable, 5: Comfortable

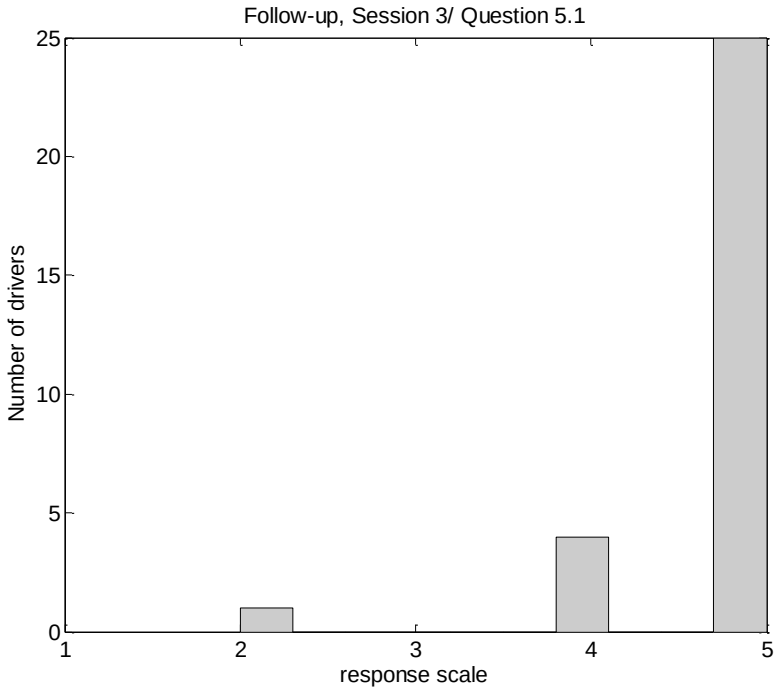


Question 4: Do you think your driving today is representative of your normal driver behaviour? Scale: 1: Pretty much, 5: Not at all

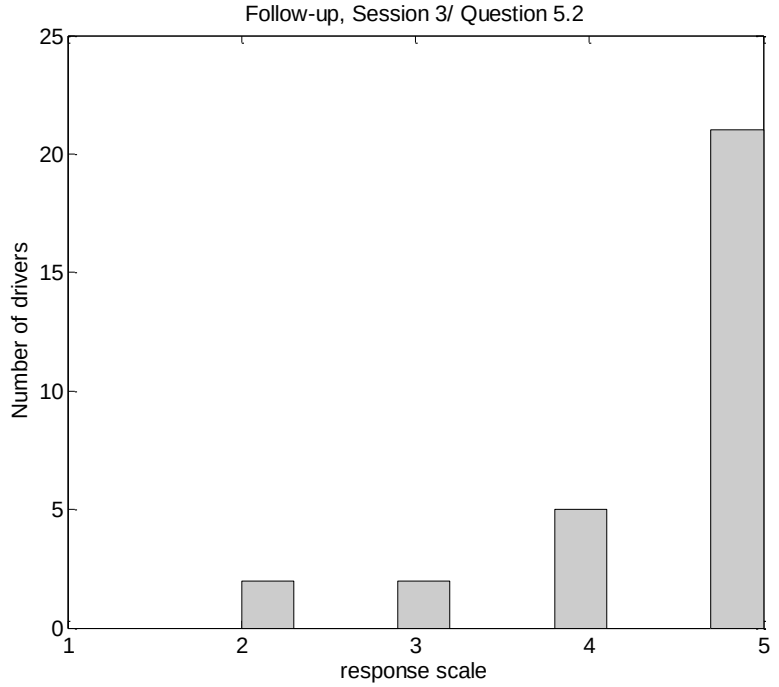


Question 5:Did you feel calm while you perform the following tasks? 1: Worried/stressful, 5: Calm

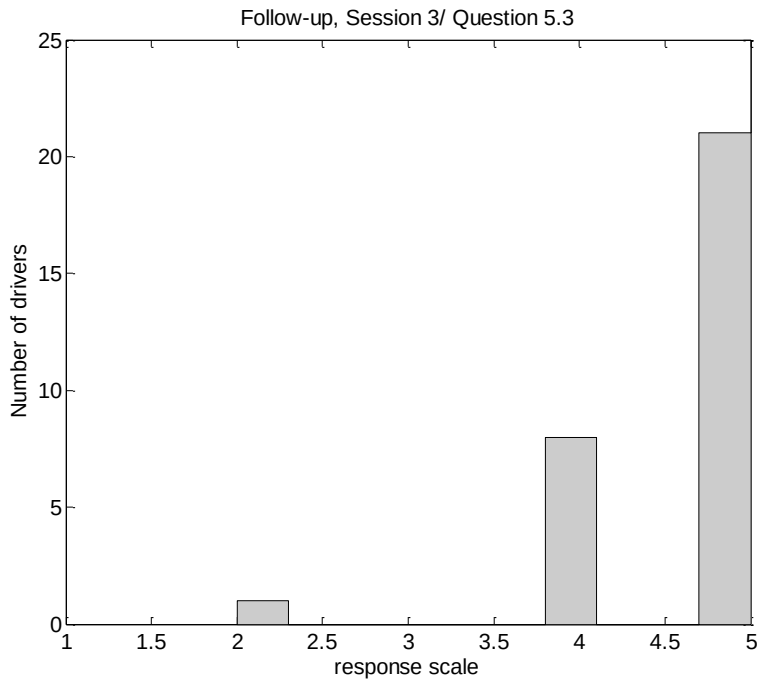
5.1: Driving under normal condition



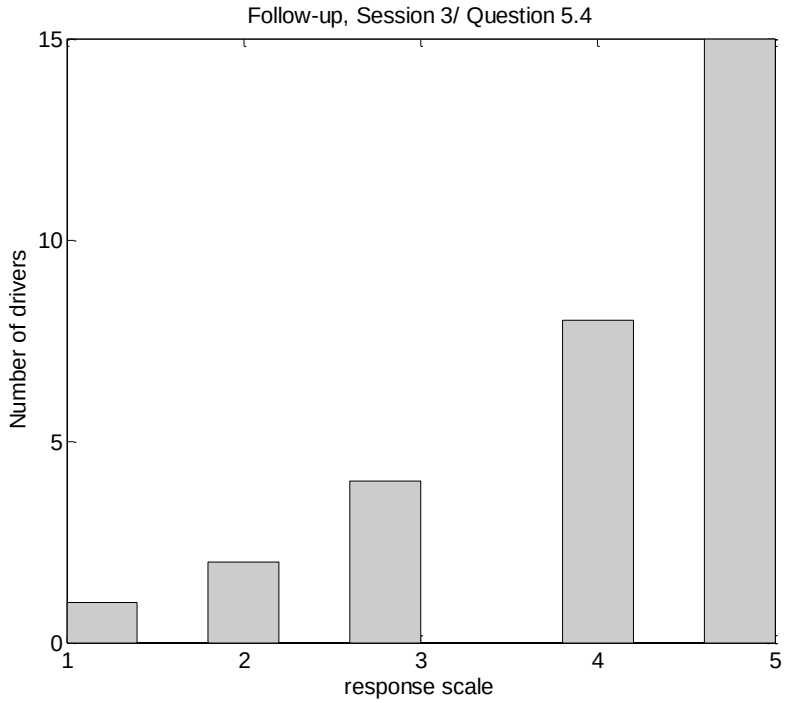
5.2. Driving while reporting road/navigation conditions



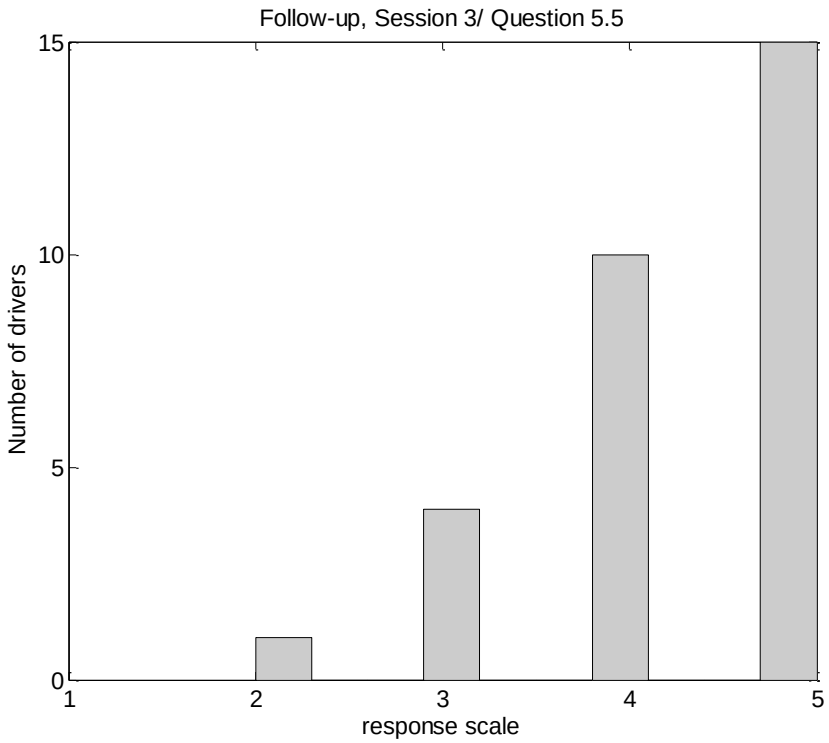
5.3. Driving while communicating with monitoring staff:



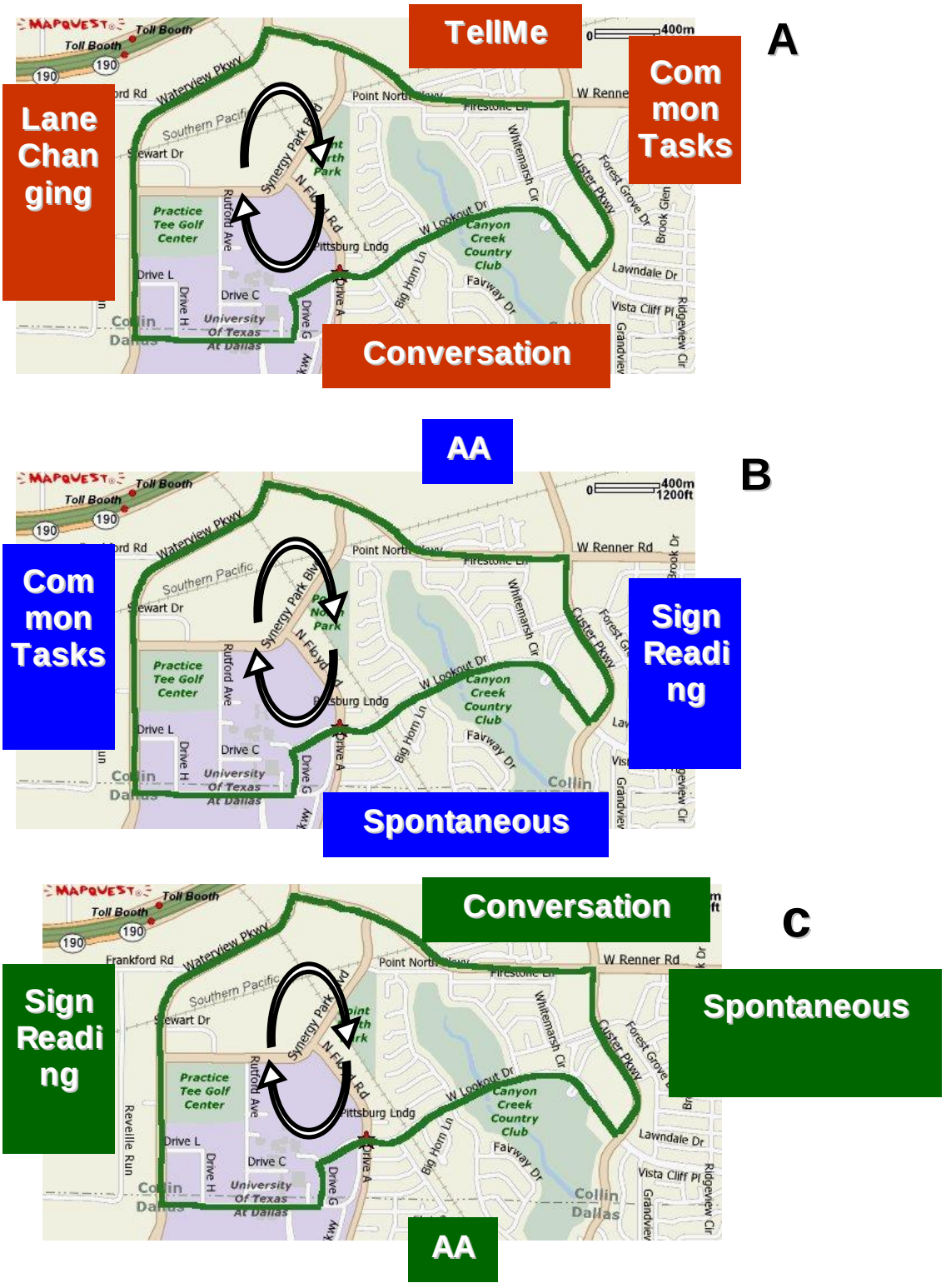
5.4: Driving while interacting with human-machine dialog system



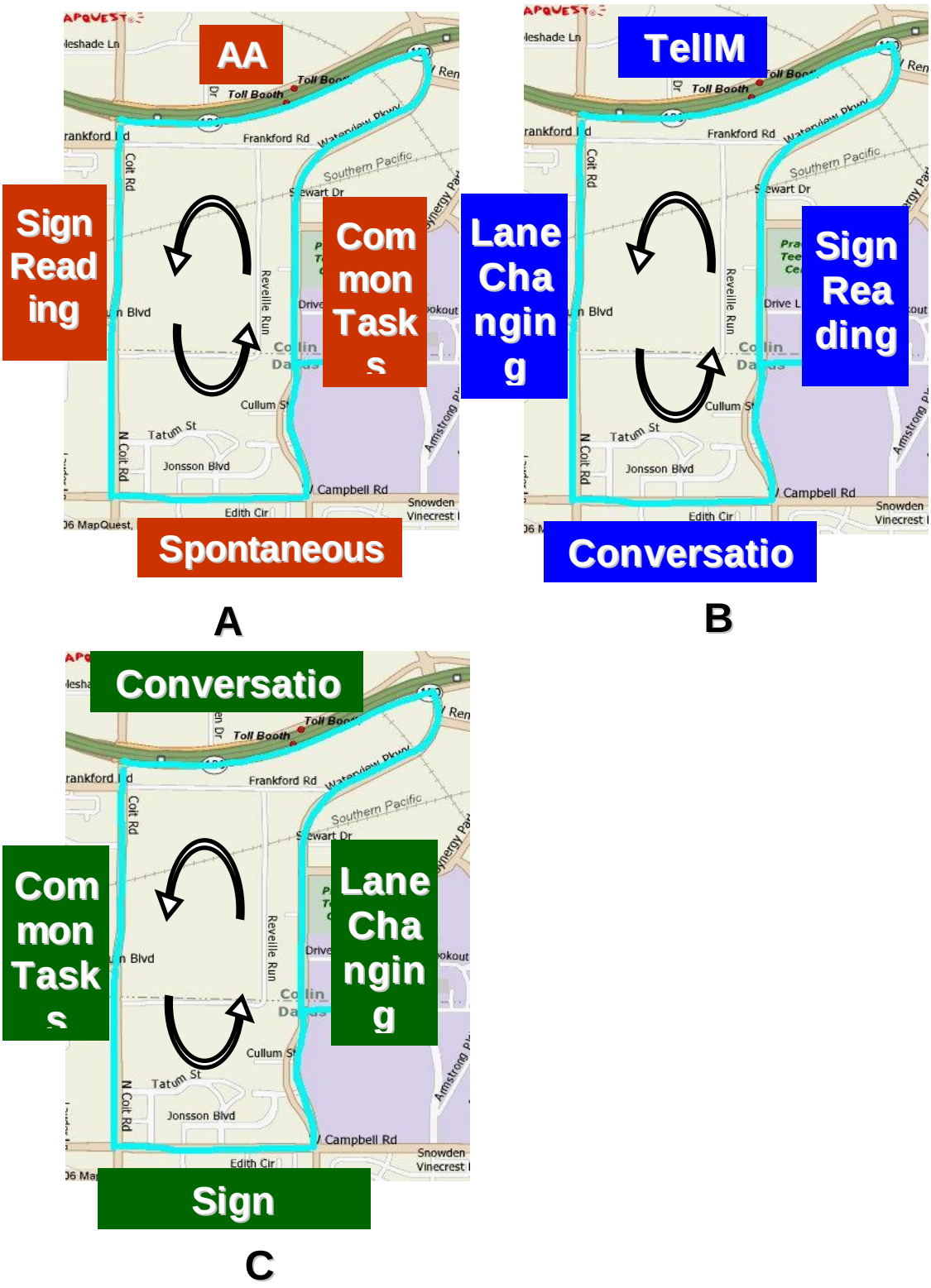
5.5. Driving while performing the other secondary tasks (e.g. radio tuning)


Follow-up, Session 3/ Question 5.5
15
10
5
0
Number of drivers
1
2
3
4
5
response scale

APPENDIX A: DRIVING ROUTE 1 AND ASSIGNED TASKS



APPENDIX B: DRIVING ROUTE 2 AND ASSIGNED TASKS



APPENDIX C: DATA LOGS for TRACKING MALE DRIVERS

C	Complete
AC	Almost Complete
IC	InComplete
E	Empty
XP	X number of Parts
*	Night driving
BW	Black and White
*'	Rainy and night

Driver	Session	Route				Video color	SENSOR
		P1	P2	P3	P4		
dm1001	**S1**	C	AC	AC	C	BW	YES
	S2	AC	C	C	AC	BW	YES
	S3	E	E	E	E	E	E
dm1002	**S1**	C	AC	IC	C	BW	YES
	S2	C	AC	C	AC	BW	YES
	S3	2P	AC	3P	AC	BW	YES
dm1003	**S1**	*C	C	*AC	*C	BW	YES
	S2	C	C	E	AC	BW	YES
	S3	E	E	E	E	E	E
dm1004	**S1**	IC	C	AC	AC	BW	YES
	S2	*C	*2P	*AC	E	BW	YES
	S3	AC	C	2P	C	BW	YES
dm1005	**S1**	C	AC	IC	IC	BW	YES
	S2	C	C	C	C	BW	YES
	S3	E	E	E	E	E	E
dm1006	**S1**	C	C	AC	AC	BW	YES
	S2	AC	AC	AC	E	BW	YES
	S3	2P	C	AC	E	BW	YES
dm1007	**S1**	AC	AC	IC	C	BW	YES
	S2	C	C	AC	C	BW	YES
	S3	E	E	E	E	E	E
dm1008	**S1**	C	C	AC	C	BW	YES
	S2	C	AC	2P	AC	BW	YES
	S3	IC	AC	C	E	BW	YES
dm1009	**S1**	C	C	AC	E	BW	YES

	S2	C	AC	AC	E	BW	YES
	S3	C	AC	C	C	BW	YES
dm1010	**S1**	AC	C	AC	E	BW	YES
	S2	C	C	AC	E	BW	YES
	S3	C	C	C	C	BW	YES
dm1011	**S1**	C	C	AC	E	BW	YES
	S2	E	C	AC	C	BW	YES
	S3	C	C	C	C	BW	YES
dm1012	**S1**	C	C	C	2P	BW	YES
	S2	C	C	C	E	BW	YES
	S3	C	2P	E	E	BW	YES
dm1013	**S1**	2P	C	C	E	BW	YES
	S2	C	2P	2P	E	BW	YES
	S3	E	E	E	E	E	E
dm1014	**S1**	2P	C	2P	E	BW	YES
	S2	E	E	E	E	E	E
	S3	E	E	E	E	E	E
dm1015	**S1**	C	C	C	E	BW	YES
	S2	2P	C	C	E	BW	YES
	S3	E	E	E	E	E	E
dm1016	**S1**	C	C	C	C	BW	YES
	S2	2P	2P	2P	IC	BW	YES
	S3	E	E	E	E	E	E
dm1017	**S1**	C	C	2P	E	BW	YES
	S2	E	E	E	E	E	E
	S3	E	E	E	E	E	E
dm1018	**S1**	IC	C	C	2P	BW	YES
	S2	E	E	E	E	E	E
	S3	E	E	E	E	E	E
dm1019	**S1**	C	C	AC	C	BW	YES
	S2	2P	2P	C	C	BW	YES
	S3	C	C	2P	2P	BW	YES
dm1020	**S1**	AC	C	C	E	BW	YES
	S2	E	E	E	E	E	E
	S3	E	E	E	E	E	E
dm1021	**S1**	2P	C	C	E	BW	YES
	S2	E	E	E	E	E	E
	S3	E	E	E	E	E	E
dm1022	**S1**	C	AC	C	2P	BW	YES
	S2	E	E	E	E	E	E

	S3	E	E	E	E	E	E
dm1023	**S1**	C	C	C	C	BW	YES
	S2	E	E	E	E	E	E
	S3	E	E	E	E	E	E
dm1024	**S1**	C	C	C	E	BW	YES
	S2	2P	C	C	E	BW	YES
	S3	IC	AC	IC	IC	BW	YES
dm1025	**S1**	IC	E	C	C	BW	YES
	S2	AC	C	C	AC	BW	YES
	S3	IC	IC	C	C	BW	YES
dm1026	**S1**	C	2P	2P	2P	BW	YES
	S2	E	E	E	E	E	E
	S3	E	E	E	E	E	E
dm1027	**S1**	IC	IC	IC	C	BW	YES
	S2	E	E	E	E	E	E
	S3	E	E	E	E	E	E
dm1028	**S1**	C	C	E	E	BW	YES
	S2	C	AC	2P	C	BW	YES
	S3	3P	C	2P	E	BW	YES
dm1029	**S1**	C	2P	IC	E	BW	YES
	S2	2P	C	C	E	BW	YES
	S3	AC	2P	C	C	Color	NO
dm1030	**S1**	C	C	AC	C	BW	YES
	S2	E	E	E	E	E	E
	S3	E	E	E	E	E	E
dm1031	**S1**	C	C	2P	E	BW	YES
	S2	C	2P	2P	E	BW	NO
	S3	2P	2P	2P	E	Color	NO
dm1032	**S1**	C	IC	2P	AC	BW	NO
	S2	2P	C	E	E	BW	NO
	S3	C	E	C	E	Color	NO
dm1033	**S1**	2P	3P	IC	E	BW	NO
	S2	IC	C	2P	C	BW	NO
	S3	2P	C	C	E	Color	NO
dm1034	**S1**	C	C	C	E	Color	NO
	S2	E	C	C	C	Color	NO
	S3	E	E	E	E	E	E
dm1035	**S1**	C	C	2P	E	Color	NO
	S2	2P	C	C	2P	Color	NO
	S3	E	E	E	E	E	E

dm1036	**S1**	C	C	C	C	Color	NO
	S2	E	E	E	E	E	E
	S3	E	E	E	E	E	E

FEMALE DRIVERS

Driver	Session	Route				Video color	SENSOR
		P1	**P2**	**P3**	**P4**		
df1001	**S1**	C	IC	C	C	BW	YES
	S2	AC	C	AC	C	BW	YES
	S3	2P	3P	C	C	BW	YES
df1002	**S1**	C	C	C	C	BW	YES
	S2	C	C	C	C	BW	YES
	S3	E	E	E	E	E	E
df1003	**S1**	AC	C	E	E	BW	YES
	S2	IC	C	IC	IC	BW	YES
	S3	IC	C	C	AC	BW	YES
df1004	**S1**	IC	C	C	E	BW	YES
	S2	C	C	C	C	BW	YES
	S3	C	C	*'C	*'3P	BW	YES
df1005	**S1**	C	C	E	E	BW	YES
	S2	E	E	E	E	E	E
	S3	E	E	E	E	E	E
df1006	**S1**	C	C	IC	E	BW	YES
	S2	E	E	E	E	E	E
	S3	E	E	E	E	E	E
df1007	**S1**	2P	C	C	E	BW	YES
	S2	IC	C	2P	C	BW	YES
	S3	C	C	AC	C	BW	YES
df1008	**S1**	C	C	C	E	BW	YES
	S2	C	2P	C	C	BW	YES
	S3	C	C	C	2P	BW	YES
df1009	**S1**	C	3P	C	E	BW	YES
	S2	E	E	E	E	E	E
	S3	E	E	E	E	E	E
df1010	**S1**	C	C	2P	E	BW	YES
	S2	2P	2P	C	C	BW	YES
	S3	C	2P	2P	2P	BW	YES
df1011	**S1**	C	E	C	E	BW	YES
	S2	3P	C	C	C	BW	YES

	S3	2P	2P	2P	E	BW	YES
df1012	**S1**	C	C	2P	C	BW	YES
	S2	C	IC	2P	3P	BW	YES
	S3	2P	C	2P	E	Color	NO
df1013	**S1**	C	2P	C	2P	BW	YES
	S2	C	C	E	C	BW	YES
	S3	IC	C	2P	C	BW	YES
df1014	**S1**	2P	2P	C	E	BW	YES
	S2	E	E	E	E	E	E
	S3	E	E	E	E	E	E
df1015	**S1**	C	IC	3P	E	BW	YES
	S2	C	C	IC	C	Color	NO
	S3	E	E	E	E	E	E
df1016	**S1**	C	C	2P	E	BW	YES
	S2	E	E	E	E	E	E
	S3	E	E	E	E	E	E
df1017	**S1**	AC	2P	C	E	BW	YES
	S2	C	C	2P	E	BW	NO
	S3	2P	IC	2P	2P	Color	NO
df1018	**S1**	C	C	C	2P	BW	YES
	S2	C	C	C	E	BW	NO
	S3	E	E	E	E	E	E
df1019	**S1**	2P	AC	2P	C	BW	YES
	S2	3P	C	2P	E	BW	NO
	S3	C	C	C	E	Color	NO
df1020	**S1**	2P	C	2P	E	BW	YES
	S2	C	E	C	IC	BW	NO
	S3	C	2P	2P	C	BW	NO
df1021	**S1**	2P	C	C	E	BW	YES
	S2	E	C	3P	E	BW	NO
	S3	E	E	E	E	E	E
df1022	**S1**	E	E	E	E	E	E
	S2	C	2P	3P	C	BW	NO
	S3	C	C	C	E	BW	NO
df1023	**S1**	3P	2P	C	E	BW	NO
	S2	2P	C	2P	C	BW	NO
	S3	C	C	C	E	Color	NO
df1024	**S1**	E	C	4P	C	BW	NO
	S2	C	C	C	C	Color	NO
	S3	2P	C	C	E	Color	NO

df1025	**S1**	C	C	C	E	BW	NO
	S2	C	E	2P	C	Color	NO
	S3	C	2P	E	E	Color	NO
df1026	**S1**	2P	C	2P	E	BW	NO
	S2	2P	C	E	E	Color	NO
	S3	E	E	E	E	E	E
df1027	**S1**	C	C	C	C	Color	NO
	S2	C	AC	IC	2P	Color	NO
	S3	E	E	E	E	E	E
df1028	**S1**	C	C	3P	IC	Color	NO
	S2	E	E	E	E	E	E
	S3	E	E	E	E	E	E
df1029	**S1**	IC	2P	2P	E	Color	NO
	S2	IC	C	C	3P	Color	NO
	S3	E	E	E	E	E	E
df1030	**S1**	C	C	IC	E	Color	NO
	S2	C	C	C	3P	Color	NO
	S3	E	E	E	E	E	E
df1031	**S1**	AC	AC	IC	E	Color	NO
	S2	E	E	E	E	E	E
	S3	E	E	E	E	E	E
df1032	**S1**	E	IC	C	E	Color	NO
	S2	E	E	E	E	E	E
	S3	E	E	E	E	E	E
df1033	**S1**	4P	2P	3P	2P	Color	NO
	S2	E	E	E	E	E	E
	S3	E	E	E	E	E	E
df1034	**S1**	E	2P	2P	E	Color	NO
	S2	E	E	E	E	E	E
	S3	E	E	E	E	E	E
df1035	**S1**	2P	C	C	C	Color	NO
	S2	IC	C	AC	E	Color	NO
	S3	C	3P	C	C	Color	NO
df1036	**S1**	2P	C	2P	E	Color	NO
	S2	E	E	E	E	E	E
	S3	E	E	E	E	E	E
df1037	**S1**	3P	IC	2P	E	Color	NO
	S2	E	E	E	E	E	E
	S3	E	E	E	E	E	E
df1038	**S1**	C	C	2P	C	Color	NO

	S2	E	E	E	E	E	E
	S3	E	E	E	E	E	E
df1039	**S1**	AC	E	C	2P	Color	NO
	S2	E	E	E	E	E	E
	S3	E	E	E	E	E	E
df1040	**S1**	2P	2P	C	2P	Color	NO
	S2	E	E	E	E	E	E
	S3	E	E	E	E	E	E

APPENDIX H: SPEAKER FORM AND QUESTIONNAIRES

UTDRIVE

Center for Robust Speech Systems
University of Texas at Dallas

SPEAKER INFORMATION FORM

(NOTE: personal information contained here will be held confidence and used for research purposes only)

PARTICIPANT ID Number: _____

DATE: _____ TIME: _____ AM PM

4. Name: _____(please print)

5. Age: _____ Date of Birth (mm/dd/yy): _____

6. Gender (circle one): Male Female

7. TOTAL number of years of formal schooling completed (High School = 12 years, B.A. = 16 years):

_____

8. What is your occupation?

_____

9. Where were you born? (city, state, country)

_____

10. Where did you live since your birth?

_____

11. What is your native language, and what language you speak most of the time?

_____

___

12. How long have you been driving a car? _____ Years

_____ Months

13. How often do you use cell-phone when you drive?

_____

14. What type of do car you normally drive? (Please specify Make & Model)

_____

___

4 Cylinder **6 Cylinder** **8 Cylinder**

Manual (stick) **Automatic**

15. What type of roadways do you drive most of the time? (e.g., highway, small town, big city)

_____

16. How often do you drive? (e.g., daily, once a week, etc.)

_____

General purposes (Please circle all that apply).

Commuting Leisure Shopping Other

_____

17. Have you ever attended a driving school? YES NO

18. Have you ever received s driving ticket? YES NO

19. Have you ever been involved in a driving accident? YES NO

Other comments:

UTDrive

Center for Robust Speech Systems
University of Texas at Dallas

SPEAKER SURVEY FORM

(NOTE: personal information contained here will be held confidence and used for research purposes only)

PARTICIPANT ID Number: _____

NAME: _____ DATE: _____

INSTRUCTION:

When you drive, you might be nervous or strenuous continuously, and become very tired afterward. Please imagine when a given circumstance persists, whether you might be under stress and become tired later. Please tell us how stressed you might be.
In your daily life, when you have to drive for awhile under the circumstances described below, how stressed would you usually feel? Please refer to the descriptions on the right (e.g., I'll drive normally, etc.), and circle 1, 2, 3, 4 or 5 which best describes your stress level. Please select only 1 number. (Please answer instinctively without analyzing the situation.)

		I'll drive normally	I will drive carefully, but it's not stressful for me	I would feel a little stressed to drive under this condition	I would feel nervous and stressed, It would be a lot of stress for me	It is too stressful. I wouldn't want to drive under this condition
1.	Driving where there are many unexpected movements, such as bicycles going between cars and suddenly coming out from the crossing streets.	1	2	3	4	5
2.	Driving at night where brightness changes because of a varying number of street lights.	1	2	3	4	5
3.	Driving while feeling upset due to reasons that are not related to driving.	1	2	3	4	5

		I'll drive normally	I will drive carefully, but it's not stressful for me	I would feel a little stressed to drive under this condition	I would feel nervous and stressed, It would be a lot of stress for me	It is too stressful. I wouldn't want to drive under this condition
4.	Driving late at night.	1	2	3	4	5
5.	Driving in a traffic jam where there is no way out.	1	2	3	4	5
6.	Driving while feeling pain, stiffness, or numbness in the legs, hip or back due to the driving conditions.	1	2	3	4	5
7.	Driving while looking for the routes or destination using the road signs or map.	1	2	3	4	5
8.	Driving when it is too cold, such as when the air conditioning is too strong in the summer, or it takes time before the car starts warming up in the winter.	1	2	3	4	5
9.	Driving on a mountain road or wilding road which requires more attention to steering and acceleration.	1	2	3	4	5
10.	Driving in a seat that is soft (too flexible?) and does not fit with your body.	1	2	3	4	5
11.	Driving on a road on which many cars are parked.	1	2	3	4	5
12.	Driving when it is difficult to see the road and the surroundings due to the direct sunlight from sunset or sunrise.	1	2	3	4	5
13.	Driving with passenger(s).	1	2	3	4	5
14.	Driving when your daily life schedule is out of balance.	1	2	3	4	5
15.	Driving at a speed slower than what you would like, such as the speed limit being too low for you.	1	2	3	4	5
16.	Driving for a long time without getting out of the vehicle often.	1	2	3	4	5

17.	Driving when you are not sure of where you are driving due to the reasons such as you are not familiar with the roads in the area.	1	2	3	4	5
		I'll drive normally	I will drive carefully, but it's not stressful for me	I would feel a little stressed to drive under this condition	I would feel nervous and stressed, It would be a lot of stress for me	It is too stressful. I wouldn't want to drive under this condition
18.	Driving when it is hot in the vehicle due to direct sunlight, etc.	1	2	3	4	5
19.	Driving with careful steering on narrow roads continuously.	1	2	3	4	5
20.	Driving in a seat whose shape does not fit your body.	1	2	3	4	5
21.	Driving on a road which has many stops (such as crossings) and you have to make sure that the road is clear every time.	1	2	3	4	5
22.	Driving on a road whose pattern/shape change frequently. For example, a road that is a mixture of straight, turns, merging and splitting, such as highways in big cities.	1	2	3	4	5
23.	Driving with people who might make you nervous, such as your boss, teacher, etc.	1	2	3	4	5
24.	Driving when you feel sick (illness such as cold or headache).	1	2	3	4	5
25.	In traffic jam, driving with frequent breaking and accelerating.	1	2	3	4	5
26.	Driving drowsy due to a lack of rest.	1	2	3	4	5
27.	Driving when the road signs to the destination are difficult to understand.	1	2	3	4	5
28.	Driving when the air in the vehicle is not clean due to dust, exhaust, etc.	1	2	3	4	5
29.	Driving when you are not comfortable with how the control of pedal feels, such as accelerating or breaking.	1	2	3	4	5

30.	Driving when you are not comfortable with the positions of seat, wheel or pedal.	1	2	3	4	5
31.	Driving when you are not used to the dimensions of the vehicle. (e.g., driving a large SUV in a city for the first time.)	1	2	3	4	5
		I'll drive normally	I will drive carefully, but it's not stressful for me	I would feel a little stressed to drive under this condition	I would feel nervous and stressed, It would be a lot of stress for me	It is too stressful. I wouldn't want to drive under this condition
32.	Driving on a road whose lane structures are complicated, such as multiple lanes for left turn only and right turn only, or your lane being an irregular mixture of left turn lane, right turn lane and straight lane.	1	2	3	4	5
33.	Driving when you are carrying items that are fragile, unstable, or expensive which requires extra care.	1	2	3	4	5
34.	Driving after psychologically stressful work.	1	2	3	4	5
35.	Driving while you are not sure of when you will reach your destination.	1	2	3	4	5
36.	Driving when the noise level or vibration level (up and down) in the vehicle is high.	1	2	3	4	5
37.	Driving when you cannot see the environment (forward, or around) well due to conditions, such as luggage, people in the vehicle, windows being dirty, etc.	1	2	3	4	5
38.	Driving when it is raining.	1	2	3	4	5

Please make sure that there are no unanswered questions.

Thank you very much for your participation.

UTDrive

Center for Robust Speech Systems
University of Texas at Dallas

QUESTIONNAIRE FORM

(NOTE: personal information contained here will be held confidence and used for research purposes only)

PARTICIPANT ID Number:_____

NAME: _____DATE: _____

INSTRUCTION:

- Please tell us how you operate a vehicle.
- How well does each statement below describe how you drive normally?
- Please refer to the descriptions on the right (e.g., not true at all, maybe true, etc.), and circle 1, 2, 3 or 4 depending on how closely each statement below describes your usual driving.
- There is no right or wrong answer.
- Please respond honestly.
- Please answer instinctively without analyzing the situation.

		Not True	Partially True	Mostly True	True
1.	I'm not good at changing lanes in a traffic jam.	1	2	3	4
2.	I use the train or bus rather than a car when the distance is not very far.	1	2	3	4
3.	I don't mind others cutting into the lane in front of my car. I keep distance from the car in front.	1	2	3	4
4.	I always follow signs that require me to slow down or stop.	1	2	3	4

5.	I slow down or speed up from a distance based on the traffic lights ahead.	1	2	3	4
		Not True	**Partially True**	**Mostly True**	**True**
6.	When I have problems, I sometimes cannot concentrate on driving.	1	2	3	4
7.	I think cars are simply a mode of transportation and any car will do as long as it runs.	1	2	3	4
8.	I am always worried that I might run over pedestrians.	1	2	3	4
9.	I avoid parking in areas where parking is prohibited and/or restricted even if it is for a short time.	1	2	3	4
10.	I am confident at estimating the dimensions of a vehicle. (e.g., I can handle a car well, even when there is not plenty of space/width on the road or in a parking lot.)	1	2	3	4
11.	When I drive, I choose a wide and well maintained road with traffic lights instead of a small road, as often as possible.	1	2	3	4
12.	I prefer moving forward even if I have to change lanes.	1	2	3	4
13.	I check to make sure I can carefully change lanes, even near intersections.	1	2	3	4
14.	I adjust my speed in order to avoid having to stop at upcoming traffic lights.	1	2	3	4
15.	I think a car should reflect who you are (ex. I prefer cool looking cars).	1	2	3	4
16.	Depending on whether I'm in a good mood or not, I may drive carelessly or fast.	1	2	3	4
17.	I worry that I might cause car accidents.	1	2	3	4
18.	I always drive below the speed limit.	1	2	3	4

Please make sure that there are no unanswered questions.

Thank you very much for your participation.

UTDrive

Center for Robust Speech Systems
University of Texas at Dallas

FOLLOW-UP QUESTIONNAIRE

(NOTE: personal information contained here will be held confidence and used for research purposes only)

PARTICIPANT ID Number: _____ Session #

_____

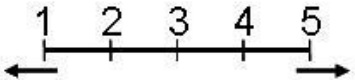
NAME:

_____

DATE: _____ TIME: _____ AM PM

20. Is your voice different from normal today?

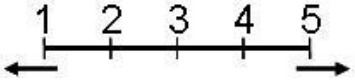
Reason: _____



Sore throat/Cold
Normal

21. How comfortable were you when you drove our car?

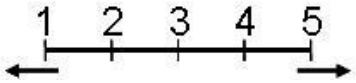
Reason: _____



Uncomfortable
Comfortable

22. How comfortable were you in following this route?

Reason: _____

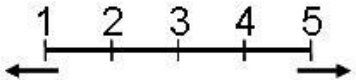


Uncomfortable

Comfortable

23. Do you think your driving today is representative of your normal driver behavior?

Reason: _____

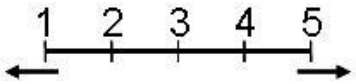


Not at all Pretty much

24. Did you feel calm while you perform the following tasks?

- ❖ Driving under the normal condition

Reason: _____

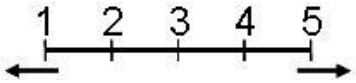


Worried/Stressful

Calm

- ❖ Driving while reporting the road/navigation conditions

Reason: _____

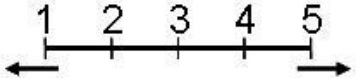


Worried/Stressful

Calm

- ❖ Driving while communicating with the monitoring staff

Reason: _____

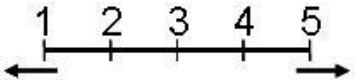


Worried/Stressful

Calm

- ❖ Driving while interacting with the human-machine dialog system

Reason: _____

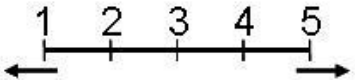


Worried/Stressful

Calm

- Driving while performing the other secondary tasks (e.g., radio tuning)

Reason: _____



Worried/Stressful

Calm

Additional comments:

_____

_____

_____

_____

_____

_____

_____

_____