Task Analysis of Manual Phone-Dialling in Nine Production Vehicles

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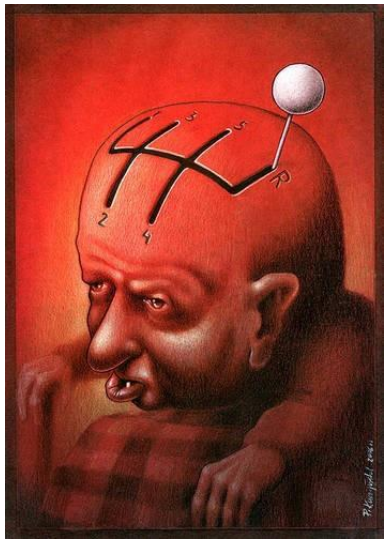
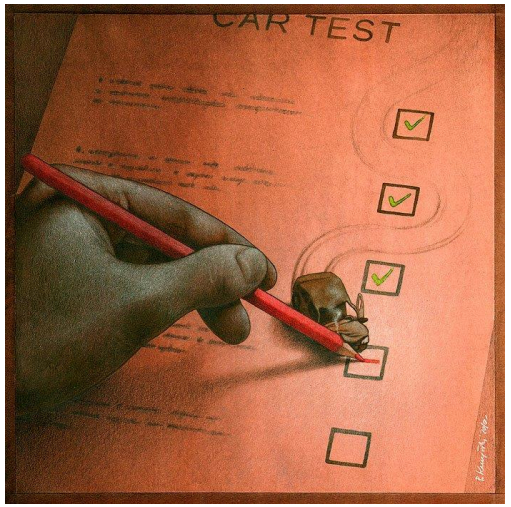
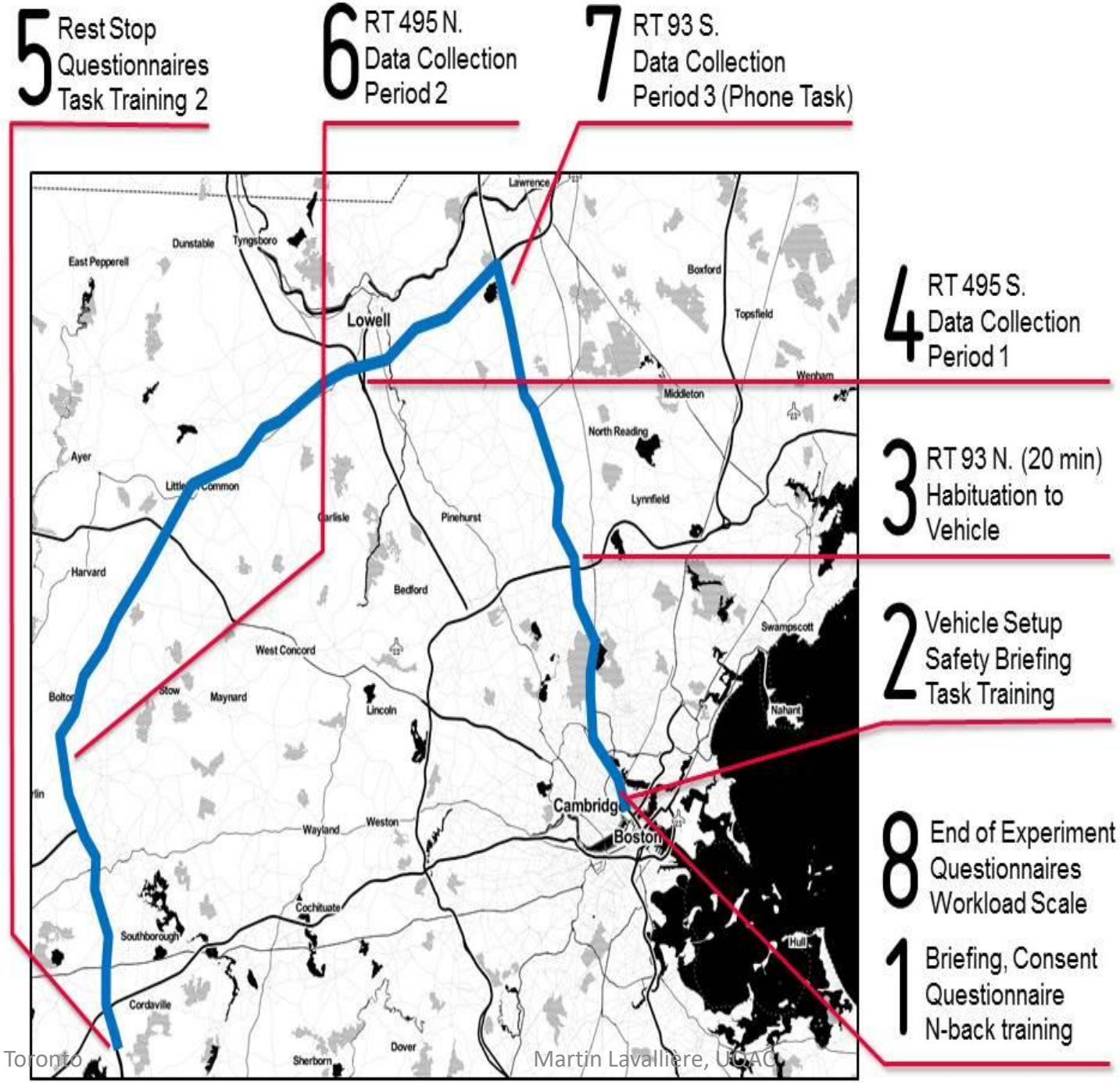




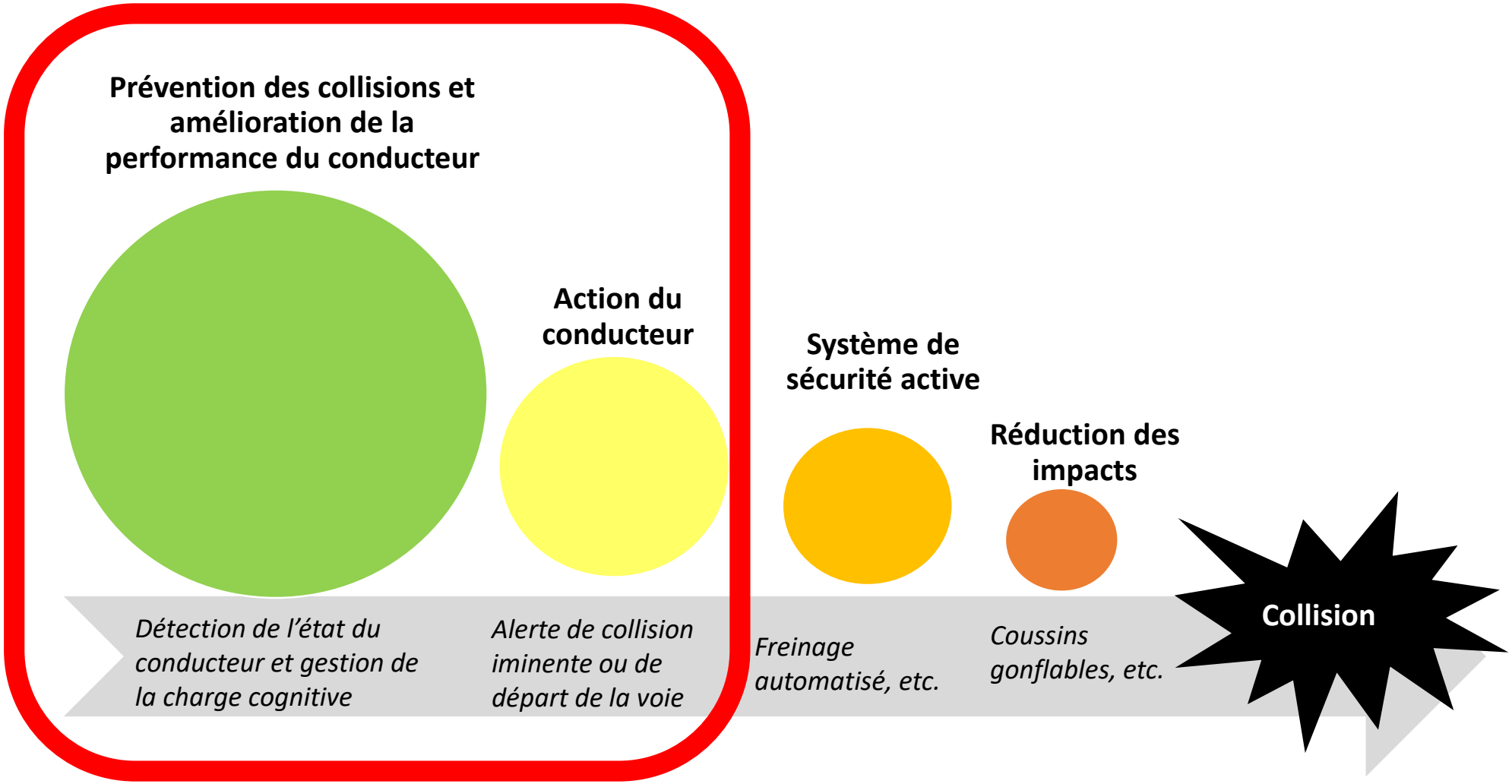
Who is a good driver ?
Qui est un bon conducteur ?

Introduction

- OEM race to implement integrated cellular technology into the vehicle
- Growing body of research suggests links between increased use of technology and unsafe driving (NHTSA, 2015)
- Human-Machine Interfaces (HMIs)
  - Lists, hierarchical menus and multitouch controls
  - Likely impact both the duration and cognitive load associated with their use


5 Rest Stop
Questionnaires
Task Training 2
6 RT 495 N.
Data Collection
Period 2
7 RT 93 S.
Data Collection
Period 3 (Phone Task)
4 RT 495 S.
Data Collection
Period 1
3 RT 93 N. (20 min)
Habituation to
Vehicle
2 Vehicle Setup
Safety Briefing
Task Training
8 End of Experiment
Questionnaires
Workload Scale
1 Briefing, Consent
Questionnaire
N-back training
Lawrence
Dunstable
Tyngsboro
East Pepperell
Lowell
Boxford
Topsfield
Wenham
Middleton
North Reading
Lynnfield
Ayer
Littleton Common
Carlisle
Pinehurst
Harvard
Bedford
West Concord
Swampscott
Bolton
Stow
Maynard
Lincoln
Nahant
Cambridge
Boston
Wayland
Weston
Cochituate
Southborough
Hull
Cordaville
Dover
Sherborn

Preventing collision



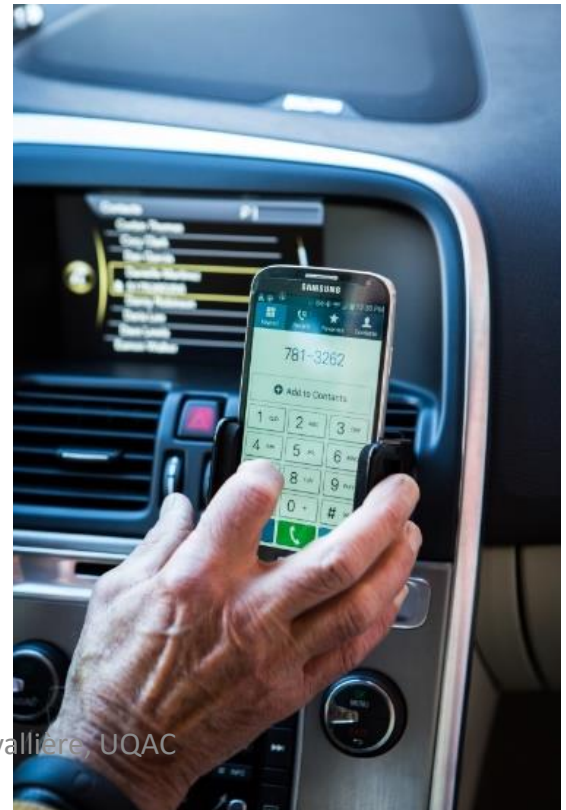
Objectives

- Three American vehicles, three European vehicles, and three Asian vehicles were selected and assessed to provide a range comparisons across manufacturers from different regions of the world.

- Moreover, we extend Reagan and Kidd's methodology by introducing a second, more difficult dialing task that included contact with multiple numbers
  - home, business, or cell etc. for a given contact.

Reagan and Kidd (2013)

- Hierarchical task structure method to examine current implementations of a standardized, manual cell phone dialing task
  - Reimer et al. 2013



Methods : Vehicules

- European
  - 2014 Mercedes Benz CLA250; 2014 BMW X5; 2013 Volvo XC60
- Asian
  - 2014 Hyundai Santa Fe; 2014 Toyota Highlander; 2014 Mazda 3
- American
  - 2013 Chevrolet Equinox; 2014 Jeep Grand Cherokee; 2010 Lincoln MKS

Methods : the dialing task

- Trained researcher performed the same task in all 9 vehicules
- Cellphone linked to the vehicle interface using Bluetooth© conenction
- The Easy and the Hard task (Mehler et al. 2013)
  - Easy : one possible entry (i.e. ‘Call Mary Sanders.’)
  - Hard : multiple listings (i.e. ‘Call Frank Scott at Work.’).
- Visual-manual inputs, or operations using the vehicle’s integrated interface were summed as either “press” or “rotate” operations (where a press could be depression of a physical button or touching a virtual button on a screen)
- Error-free

Table 1. Descriptive statistics by Vehicle and Complexity of Phone Dialing

* (E) : Easy, (H) : Hard

Manufacturer	Physical location of button/screen used	Total entries by the driver	Total interactions (driver + vehicle)	Press	Rotate
America					
Chevrolet (E)	Console	7	14	4	3
Chevrolet (H)		9	18	6	4
Jeep (E)	Touch screen	4	8	4	0
Jeep (H)		5	10	5	0
Lincoln (E)	Touch screen	5	10	5	0
Lincoln (H)		6	12	6	0
	Average	6.00	12.00	5.00	1.17
	S.D.	1.79	3.58	0.89	1.83
Europe					
Mercedes-Benz (E)	Arm rest	3	6	2	1
Mercedes-Benz (H)		5	10	3	2
BMW (E)	Arm rest	3	6	2	1
BMW (H)		5	10	3	2
Volvo (E)	Console	3	6	2	1
Volvo (H)		5	10	3	2
	Average	4.00	8.00	2.50	1.50
	S.D.	1.10	2.19	0.55	0.55
Asia					
Hyundai (E)	Console + touch screen	4	8	4	0
Hyundai (H)		5	10	5	0
Toyota	Touch screen	5	10	5	0
Toyota (H)		5	10	5	0
Mazda (E)	Arm rest	7	14	5	2
Mazda (H)		7	14	5	2
	Average	5.50	11.00	4.83	0.67
	S.D.	1.22	2.45	0.41	1.03
	Easy All	4.56	9.11	3.67	0.89
	Hard All	5.78	11.56	4.56	1.33
	Grand Average	5.17	10.33	4.11	1.11
	Average S.D.	1.37	2.74	0.62	1.14

Results
All vehicules

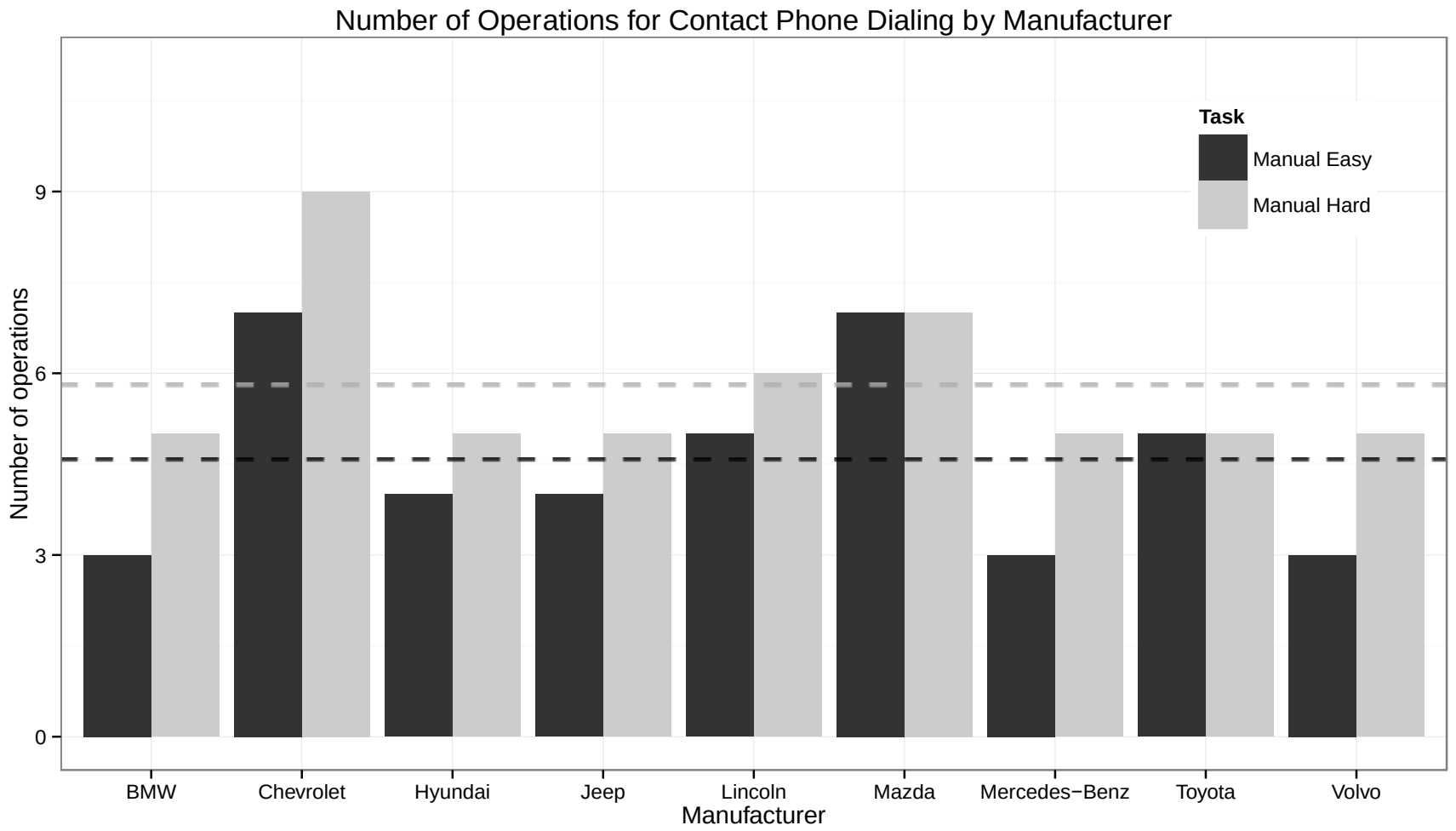


Figure 1. Number of operations for contact phone dialing by vehicle and by task difficulty. *The black dotted line represents the average number of operations for the easy dialing task whereas the gray dotted line represents the hard dialing task.*

Results
By Country

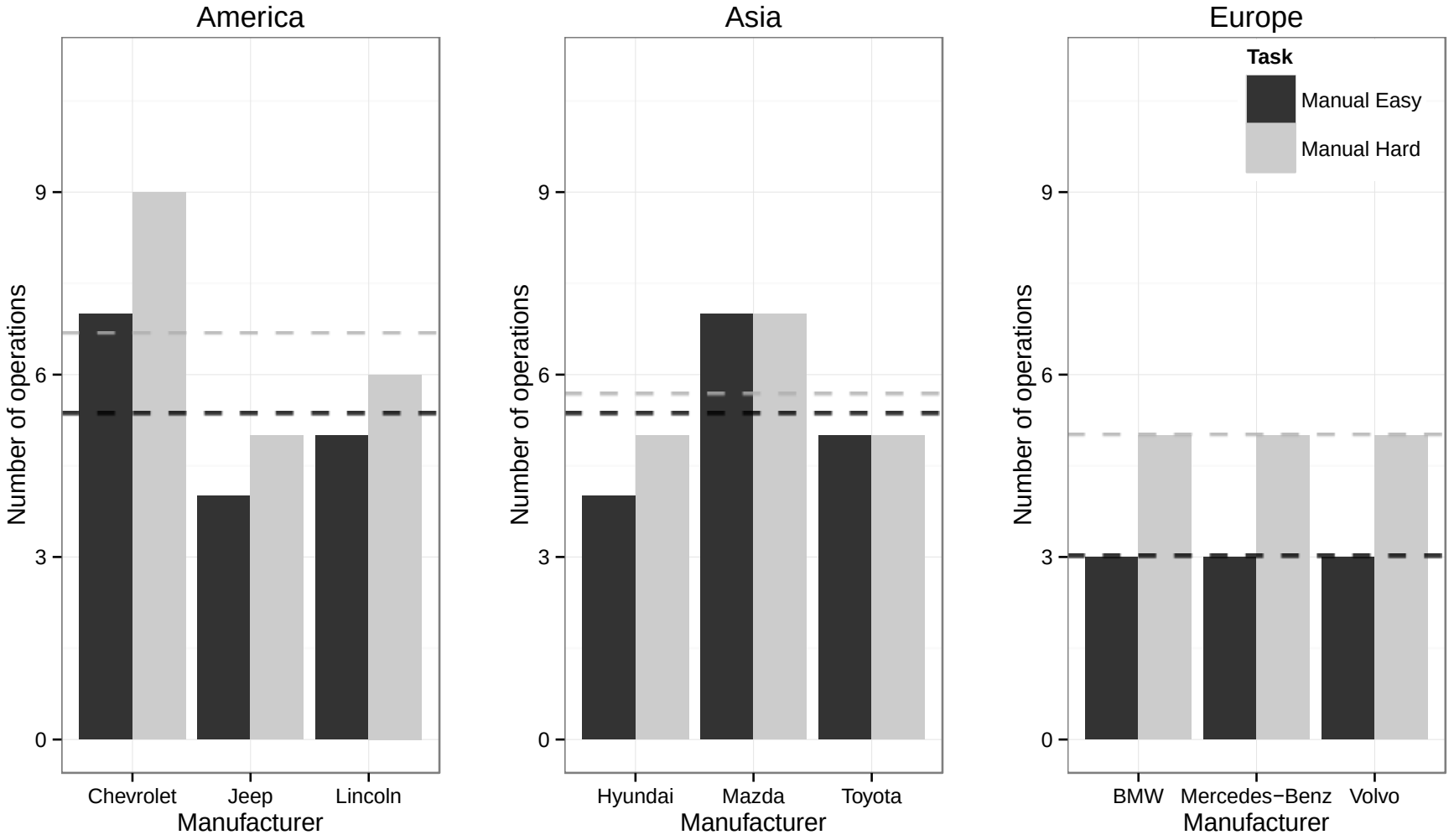


Figure 2. Number of operations for contact phone dialing by region. *The black line represents the average number of operations for the easy dialing task whereas the gray dotted line represents the hard dialing task.*

Discussion

- Variability across manufacturer
  - Easy vs Hard
- Trained researcher and parked vs Lay-driver on-road
- Multiple ways of entering a contact's phone number
  - typing the contact's name or inputting a 10-digit phone number
- "dead-end" situation using these types of interface

Discussion

- Previous research on voice-dialing tasks (Reagan & Kidd, 2013) has found verification steps of in-vehicle tasks can reduce errors, but may increase working memory load.
  - One shot entry vs multiple step approval

- Task completion time or glances off-road to the HMI elements

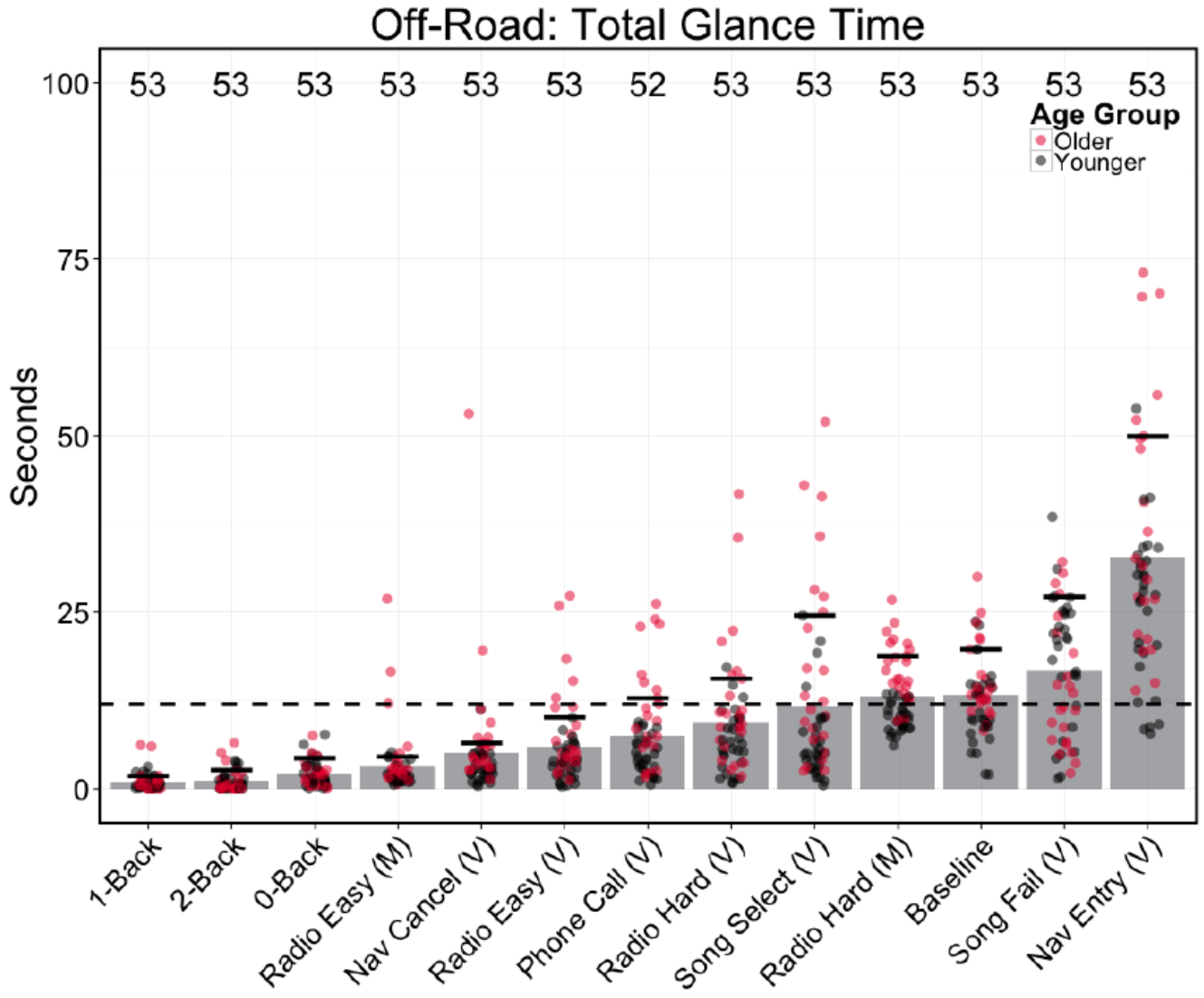


Figure 5. Total off-road glance time for each task with the NHTSA (2013) 12 second threshold shown as a dashed line. The individual line segments above each bar represent the 85% point in the sample distribution for each task. One outlier data point in the Nav Entry task is excluded from view to improve the readability of the plot. Note that the NHTSA threshold values are shown here for discussion purposes only since, among other considerations, the sample does not conform to the NHTSA recommended age distribution and the data was collected under real driving conditions as opposed to the specified simulation conditions.

Conclusion

- The strengths of this analysis lie in examining the number of observable action-based operations of tasks across HMI implementations for two types of phones dialing (i.e. “easy” vs “hard”).

- Care should be taken in assuming that two HMIs of the same general class are likely to place similar attentional / demands on the driver.
  - visual-manual interface for selecting a contact from a phone list

- Double edge sword of the OEM race

Merci
Questions

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