Trends Toward Natural User Interfaces in the Car

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Agenda

> Multimodality in the car

> User satisfaction data for speech UI in the car

> Driver distraction study on speech and visual UI

> Why is the speech button so difficult to the user?

> Guidelines for multimodal UI design

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Human Modalities for User Interfaces

Gesture

Speech

Touch

Vision

Sound

Haptic

Communication to Device

Communication to User

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Speech in the Car: Are Users Satisfied?

2012 U.S. Navigation Usage And Satisfaction Study
-- J.D. Power and Associates (Press Release 1/11/13)

➤ Satisfaction study clearly shows that drivers want speech
- 67% of the users without speech – want it
- 80% of the users with speech – want it again

➤ Speech scored the lowest satisfaction score in the study
- Significantly worse than second lowest score

➤ Speech was reported to be difficult to use
- Third most frequently reported problem in the study
- Recognition accuracy has been an issue in the car for years

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Icons: Discovery and Task Selection

- **Drivers are accustomed to touchscreen input**
  - Mobile device usage continues to grow
  - Consumers expect touchscreen in luxury vehicles
  - Mass market vehicles are adopting touchscreen

- **It can be safe to manage results with a visual / manual HMI**
  - Glancing is quick and is interruptible
  - Selecting with touch is practical and quick (limited choices)
  - Information is best perceived through vision, not speech

- **Supported by driver distraction data**
  - Across all ages, touch to select from a short list was shown to be safe
  - Audio-only interfaces exhibit high task completion times
  - It takes time to play the items to choose from

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Driver Distraction Variables of Interest

Task Duration
- Critical metric while driving

Task Accuracy
- Success rate at completing tasks

Speed Measures
- Mean Speed (mph)
- Speed Variance (mph)

Steering Measures
- Steering Variance (degrees)
- # of Lane Deviations (count)
- Time out of lane (seconds)

Eye Glances
- Glance Durations (seconds)
- Eyes Off Road Time (percentage)

Peripheral Event Detection
- %Detected/%Missed
- Latency to Detect

Workload Ratings
- Mental Demand
- Frustration Level
- Situational Awareness

Post Drive Questionnaire
- Overall Acceptability

Overview of VTTI Visual Speech Study

24 Participants
- Ages 18-30 (n=12)   Ages 65-75 (n=12)

3 User Interfaces
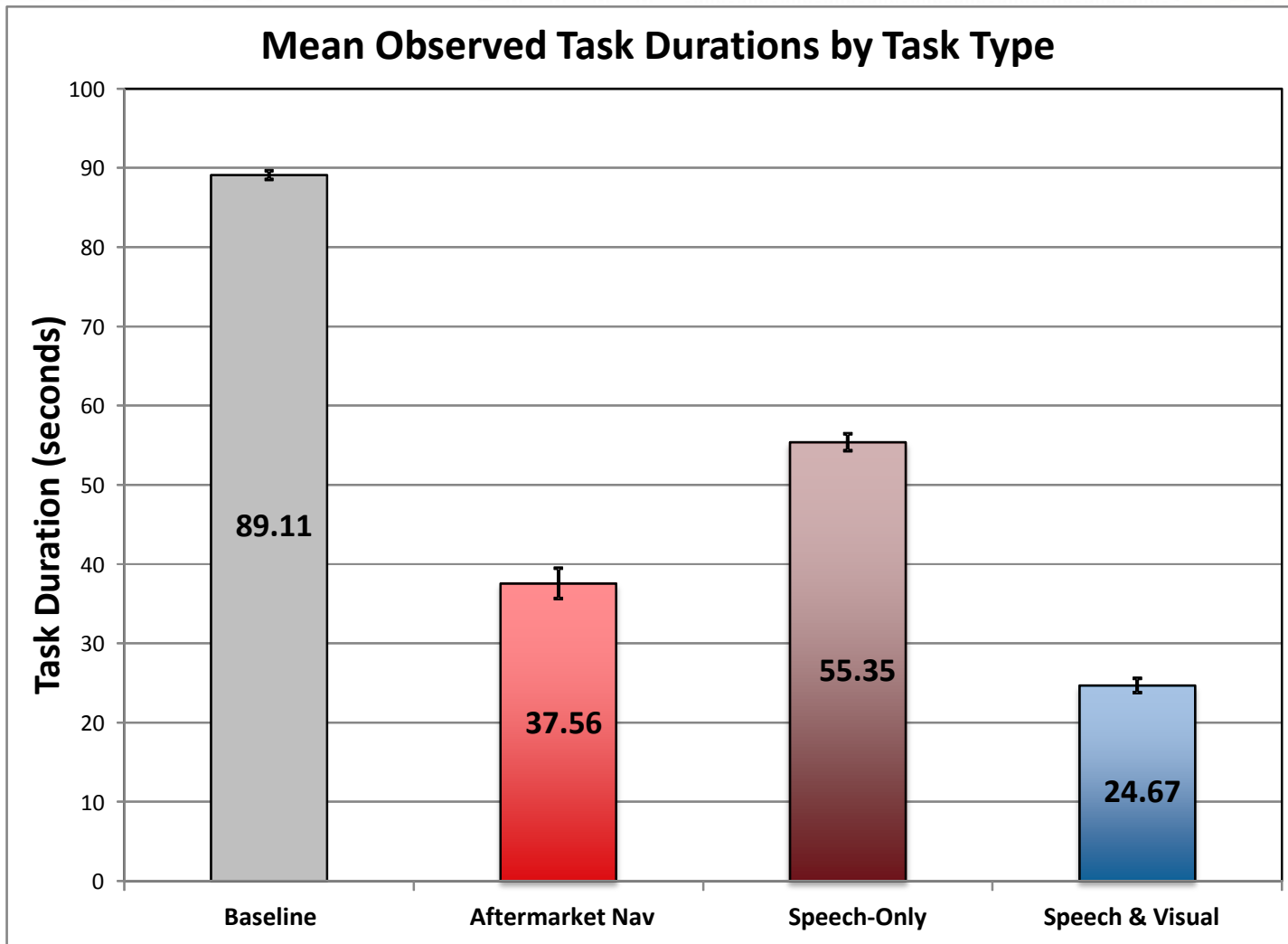- Visual & Manual, Speech Only, Speech & Visual

Destination Entry Tasks
- Address, POI, Category

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Test Vehicle Center Stack Layout

TASK DURATIONS

Task Duration Comparison

Mean Observed Task Durations by Task Type

Task Duration (seconds)

Task Type	Value
Baseline	89.11
Aftermarket Nav	37.56
Speech-Only	55.35
Speech & Visual	24.67

SPEED VARIANCE

Speed Variance

Mean Observed Vehicle Speed Variance by Task Type

Speed Variance (mph)

Baseline	Aftermarket Nav	Speech-Only	Speech & Visual
2.12	3.24	2.36	1.43

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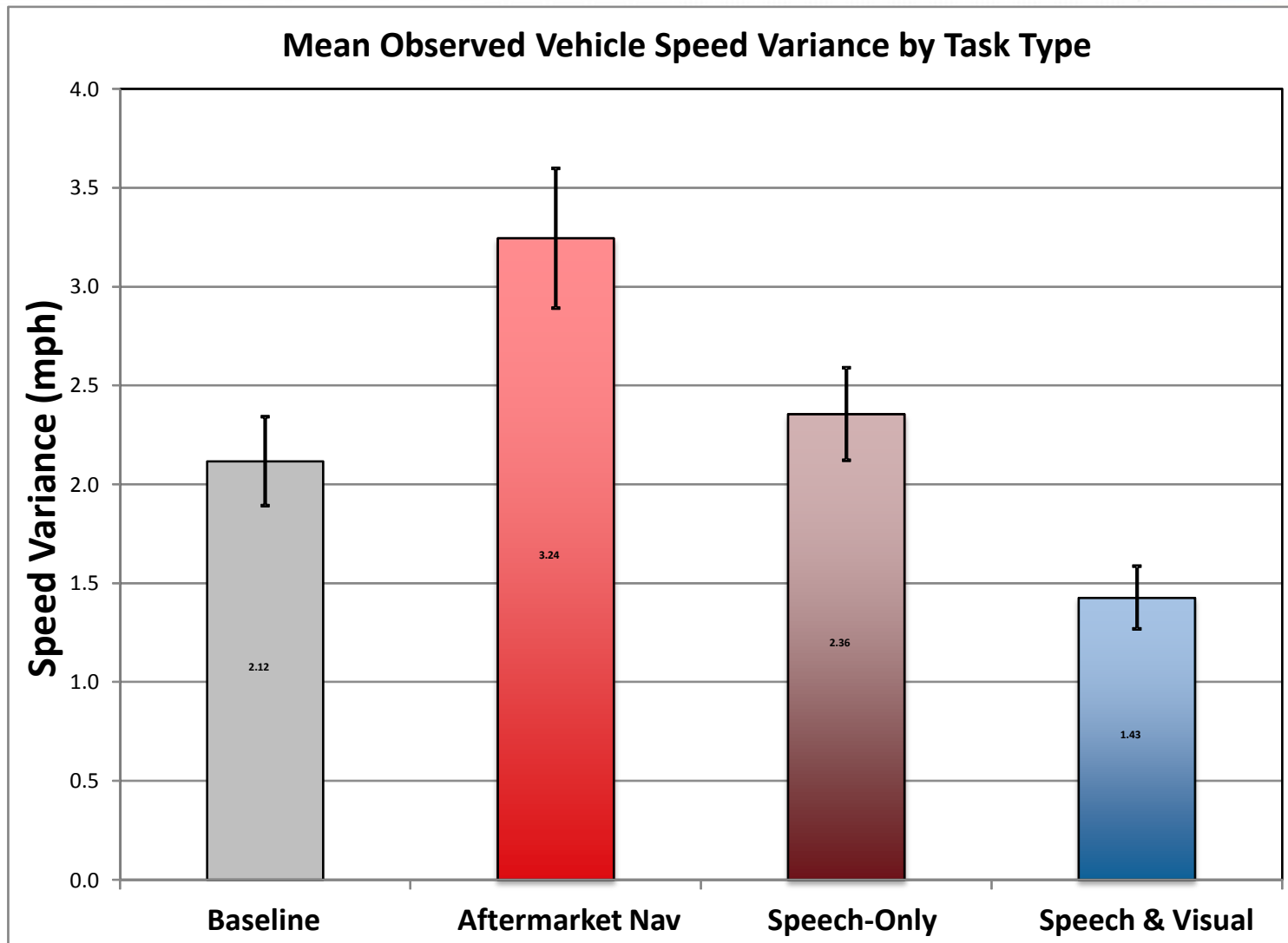
STEERING VARIANCE

Steering Variance

Mean Observed Steering Angle Variance by Task Type

Steering Variance (degrees)

- Baseline: 5.17
- Aftermarket Nav: 6.88
- Speech-Only: 5.41
- Speech & Visual: 4.35
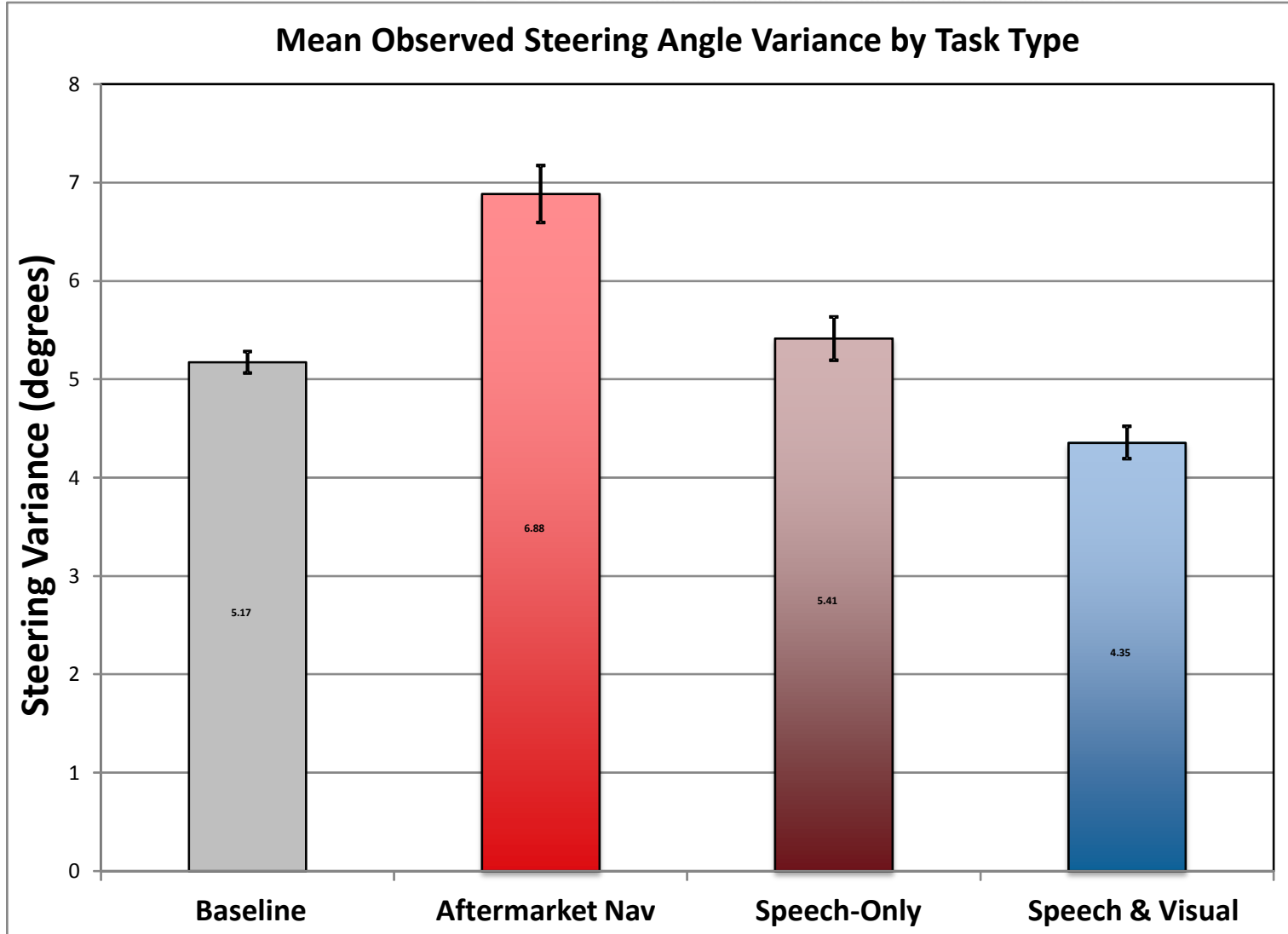
LANE DEVIATION ANALYSIS

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Mean Observed Frequency of Lane Deviations by Task Type and Age Group

■ Younger (18-30)   ■ Older (65-75)

Mean Number of Lane Deviations

Baseline: 0.00 / 0.29
Aftermarket Nav: 0.17 / 1.10
Speech-Only: 0.03 / 0.14
Speech & Visual: 0.04 / 0.11
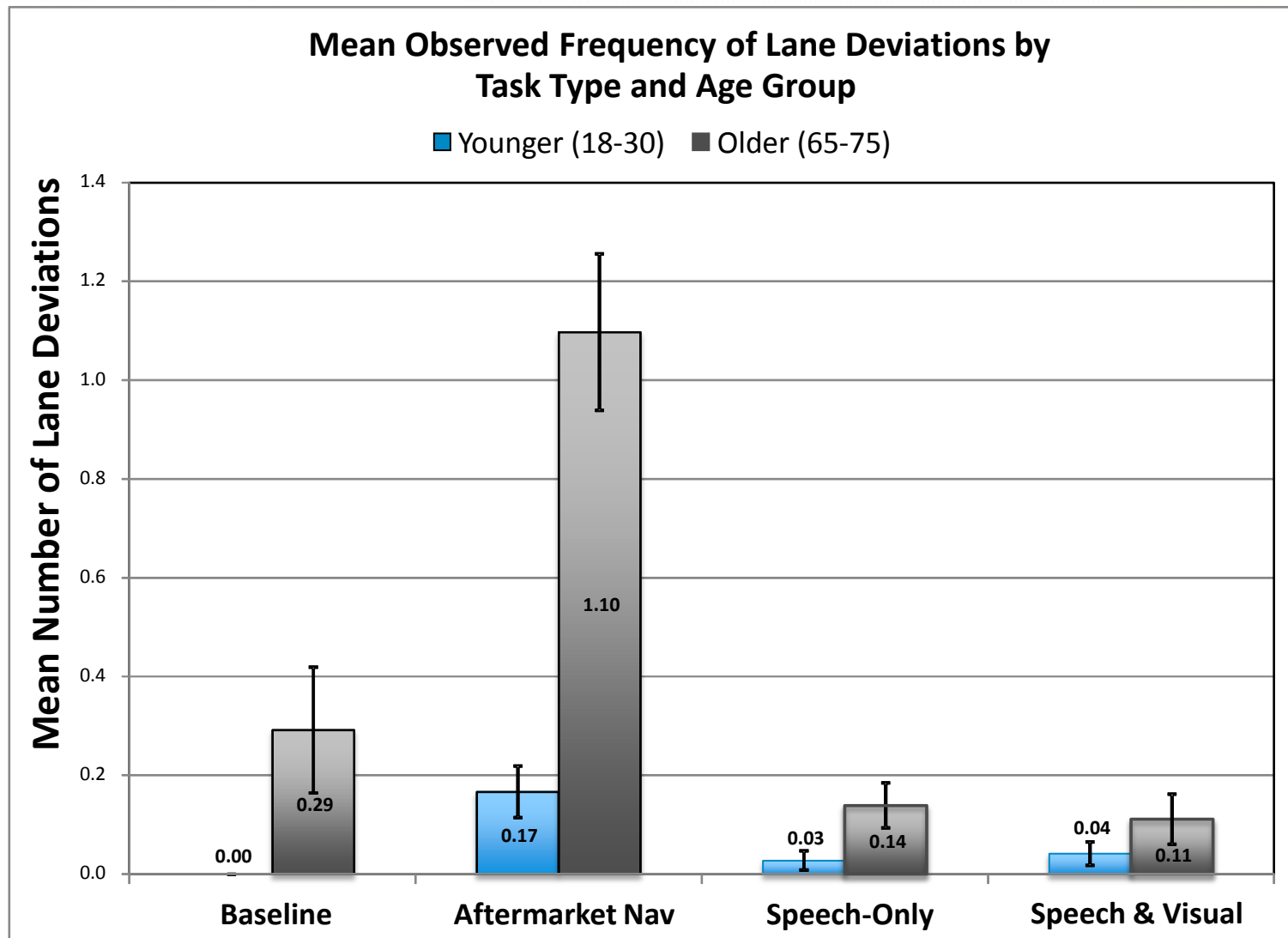
EYE GLANCE ANALYSIS

Eye Glance Data

Mean Observed Percentage of Eyes Off Road Time by Task Type
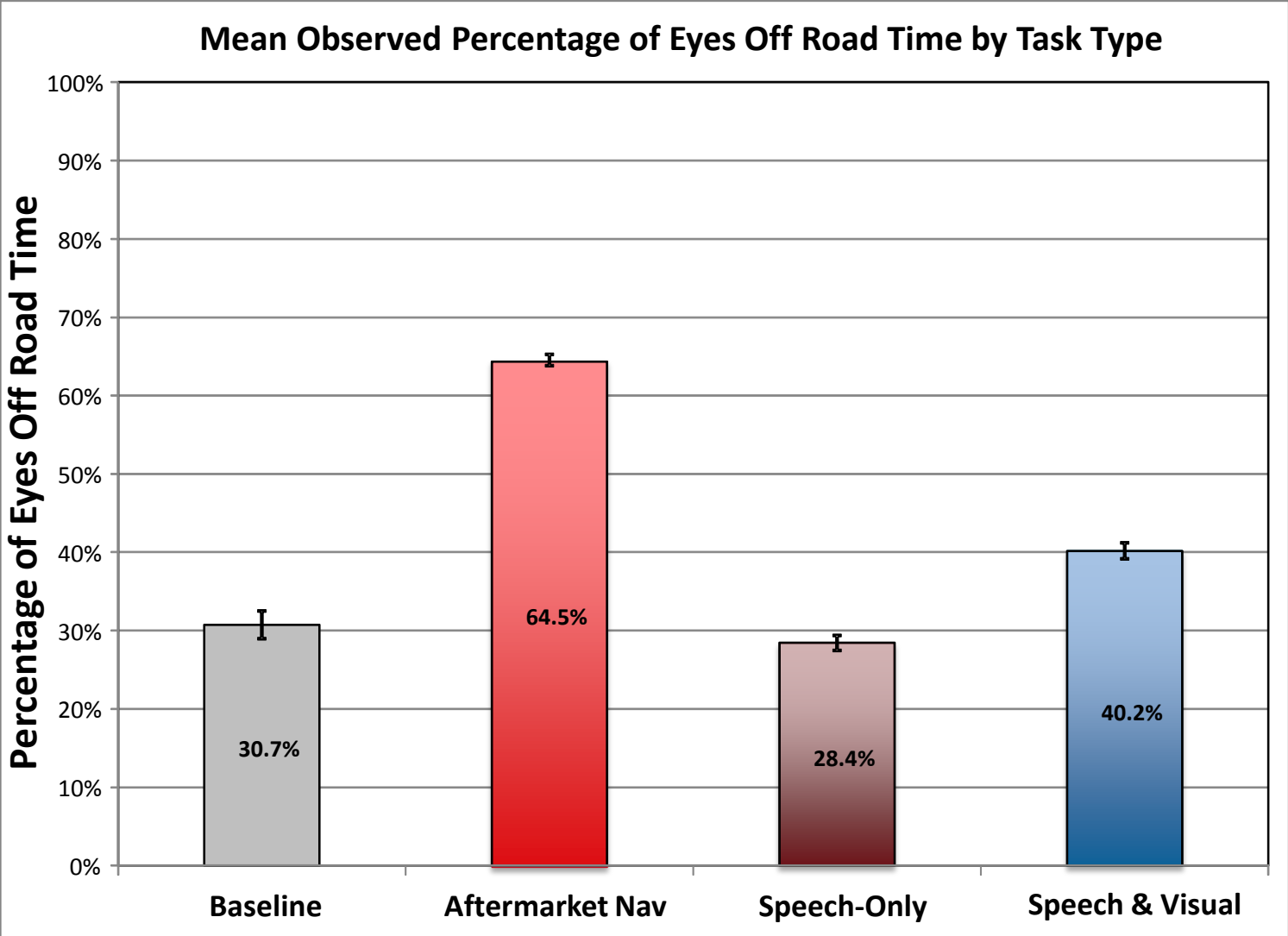
WORKLOAD RATINGS

Workload Measurement: Mental Demand

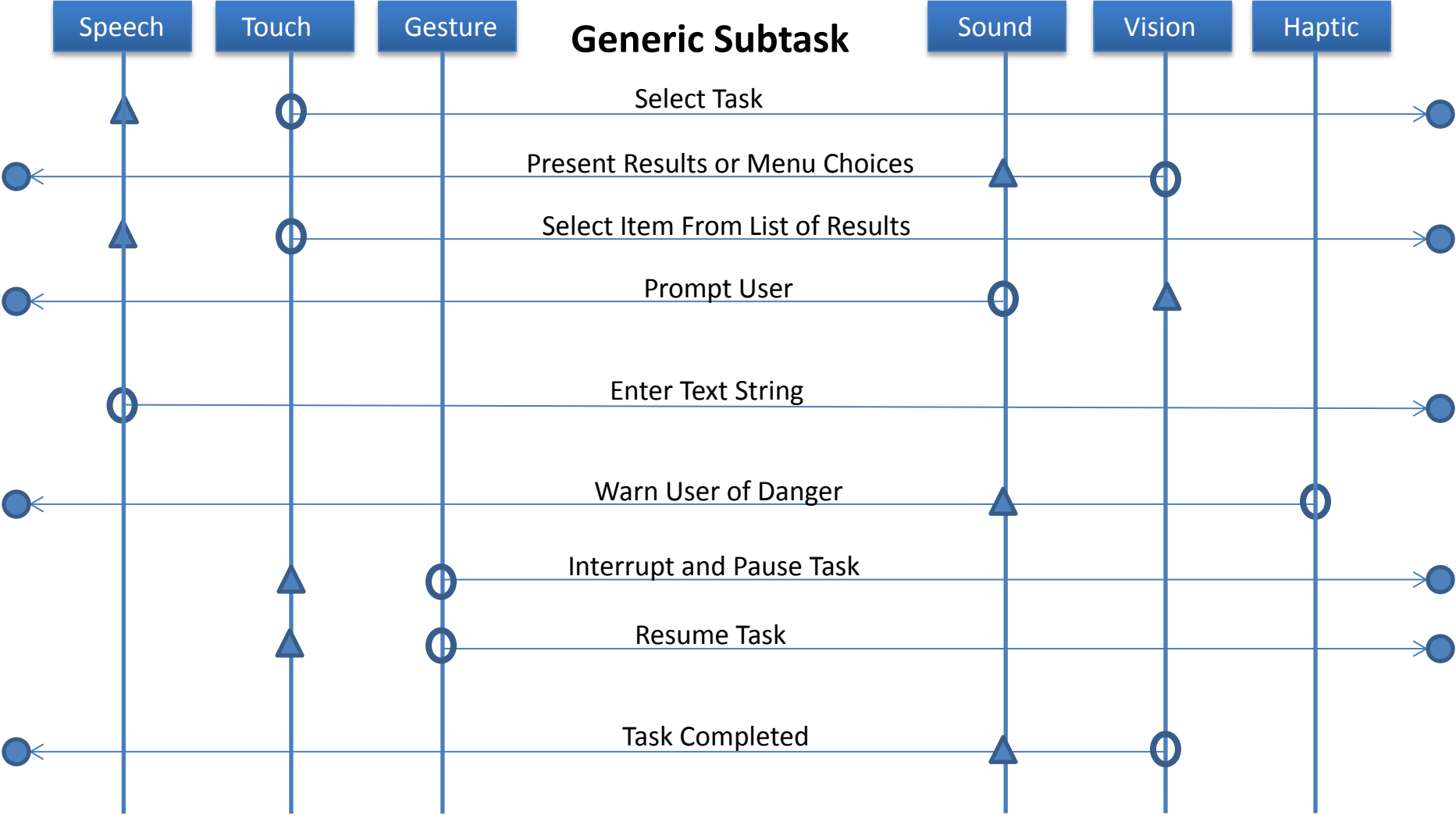**Mean Ratings of Mental Demand by Task Type**
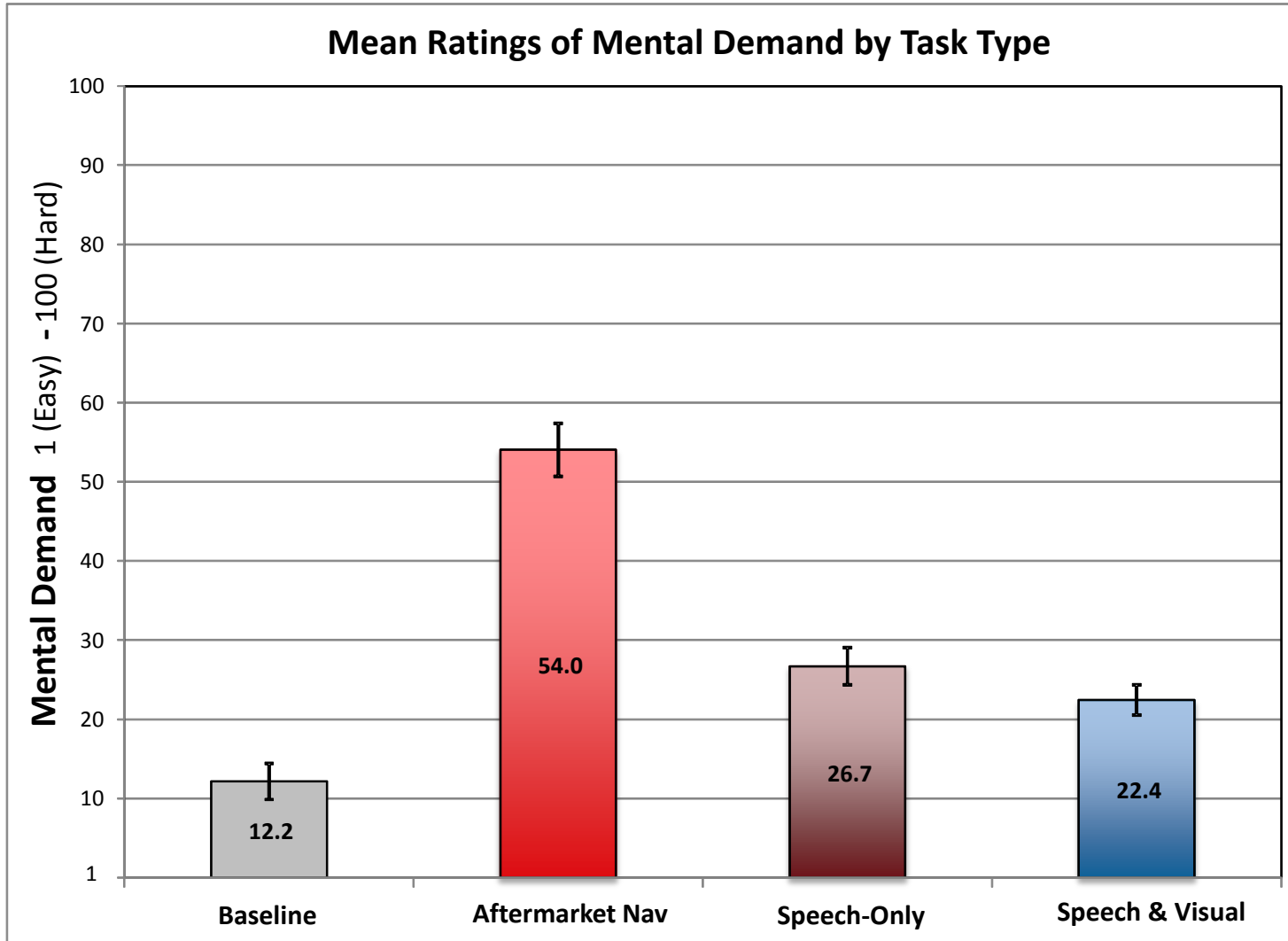
Guidelines for the Best Automotive UI

- Maximize simplicity
- Minimize # of task steps
- Minimize number of menu layers
- Avoid voice menus
- Disallow typing
- Minimize incoming messages
- Maximize interruptibility
- Minimize verbosity
- Remove need for learning mode
- Minimize speech input
- Minimize glance duration
- Minimize glance frequency
- Minimize task completion time
- Maximize driving performance

Input Modalities

Output Modalities

Speech	Touch	Gesture	Generic Subtask	Sound	Vision	Haptic

Select Task

Present Results or Menu Choices

Select Item From List of Results

Prompt User

Enter Text String

Warn User of Danger

Interrupt and Pause Task

Resume Task

Task Completed

○ - Preferred   △ - Alternate

Task Initiation Using Speech Button

"Tap or say your selection"

Scenario 1:
User taps weather icon

Scenario 2:
User says "weather"

or

Scenario 3:
User says "What's the forecast for tomorrow?"

Conclusion

- Multimodality in the car is key to usability and safety

- Speech UI in the car needs to be improved

- Driver distraction data supports mixing speech & vision

- The speech button needs to integrate with the touch screen

- More research is needed to validate proper UI design

Thank You

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