DRIVER EXPECTATIONS FOR CONTROL ERRORS, ENGAGEMENT, AND CRASH AVOIDANCE IN LEVEL 2 DRIVING AUTOMATION SYSTEMS

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Acknowledgements

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• Special thanks to project stakeholders
Project Objective

Experiment investigating how driver expectations about Level 2 driving automation capabilities affect driver engagement and performance

• Many commercially available models offer a version of simultaneous lateral and longitudinal automation
  – Capabilities vary between makes and models
• Driver expectations about capabilities will impact the way they use this technology
• Experimental approach manipulates driver expectations independently from vehicle capability
  – Phase 1 (development and pilot collection) completed Q4 2017
  – Phase 2 (data collection and reporting) beginning Q1 2018
Direct vs Indirect expectations

• Direct
  – Test drives
  – Own/operate

• Indirect
  – Prior to experiencing technology

• Sources of indirect expectation
  – News reports
  – Articles/blogs
  – Social media
Vehicle Details

Customized 2015 Infiniti Q50

- VTTI developed automation hardware and software
  - High capability (lane centering)
    - Limited driver intervention
  - Low capability (lane keeping)
    - Sinusoidal disturbance introduced
    - Requires driver intervention often
- Redundant rear seat controls
  - Initiate steering errors
  - Emergency takeovers*
Camera Views
- VTTI Flex DAS
  - 1080p resolution
  - Front
  - Over the Shoulder
  - Driver Face
  - Foot
  - Rear
Design

Manipulate participant training to set expectation

- Training is either congruent, above, or below vehicle capability
- 4 x 2 x 6 mixed design
  - 4 levels of expectation (between)
  - 2 types of crash imminent scenario (between)
  - 6 non-driving task order conditions (between)
- Non-driving task comparisons as within subjects factor

<table>
<thead>
<tr>
<th>Training</th>
<th>Capability</th>
<th>Expectation</th>
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<tbody>
<tr>
<td>Low</td>
<td>Low</td>
<td>Congruent</td>
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<tr>
<td>Low</td>
<td>High</td>
<td>Below Expectations</td>
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<tr>
<td>High</td>
<td>Low</td>
<td>Above Expectations</td>
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<tr>
<td>High</td>
<td>High</td>
<td>Congruent</td>
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Participants

Data collection completed in two phases

- Phase I: 16 participants - Complete
- Phase II: 96 participants
- Gender balanced within two NHSA age groups
  - 24-39
  - 40-54

<table>
<thead>
<tr>
<th>Task Orders</th>
<th>Crash Imminent Scenario</th>
<th>Expectation-Capability Combinations</th>
<th>Participants Per Combination</th>
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<tbody>
<tr>
<td></td>
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<td>Low-Low</td>
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<td></td>
<td></td>
<td>Younger</td>
<td>Older</td>
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</tr>
<tr>
<td>TO-6</td>
<td>Reveal</td>
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</tbody>
</table>

Total Phase 1: 16
Total Phase 2: 96
Grand Total: 112
Procedures

• Participant receives training such that they have expectation for lane keeping (Low Capability)

Training

• Participant is assigned to Lane Centering (High Capability) and drives on public roads

Experience

• Participant continues on the Smart Road while performing non-driving tasks; experiences a surprise event

Smart Road Testing

Smart Road Testing - 12 Trials

1- Video  2- Text  3- Baseline  4- Video  5- Text  6- Baseline  7- Video  Resume Trials 8-12

Surprise Event
Two types of surprise event scenarios
• Limitations of currently available systems
  – Slowed vehicle reveal
  – Road departure
Surprise Events

Two types of surprise event scenarios
• Limitations of currently available systems
  – Slowed vehicle reveal
  – Road departure
Focus on Driver Response, Engagement, and Trust

- Response times to surprise events
- Hands on wheel behavior
  - Capacitive wheel installed
- Eye glance analyses
- Subjective questionnaires
Thank You!

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