Connected and Automated Vehicles – Attitudes and Perceptions

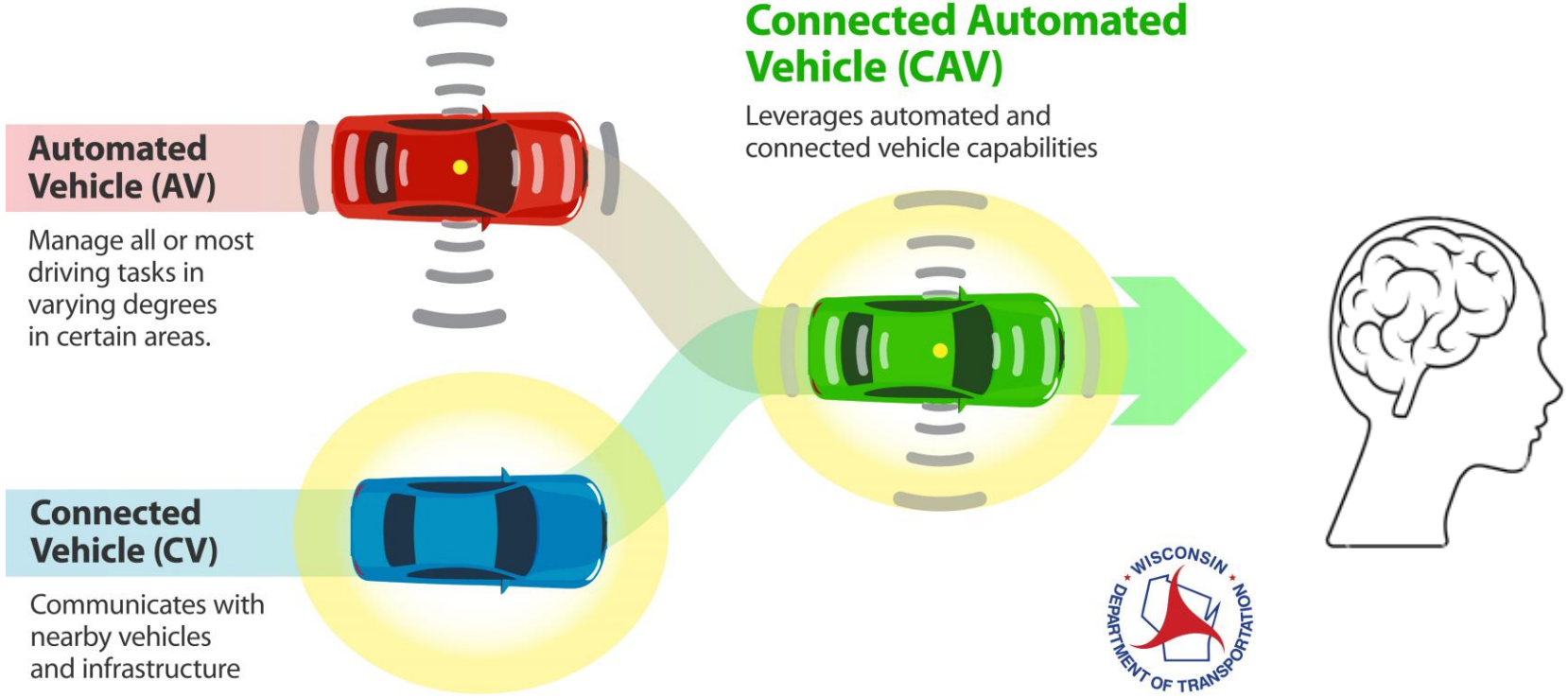


Image source: https://wisconsindot.gov/pages/projects/multimodal/cav.aspx

Wisconsin CAV Attitudes Survey
Research Motivations and Objectives

Motivation

The Wisconsin Department of Transportation (WisDOT) needs to know how people perceive connected and automated vehicle technology and what information they need to have the confidence that these new technologies will be rolled out safely. Accurate information is needed to recognize and take advantage of the safety benefits of CAVs in public investment and private purchases. Identification of the communication channels to best connect with various demographics and stakeholders is needed.

Objectives

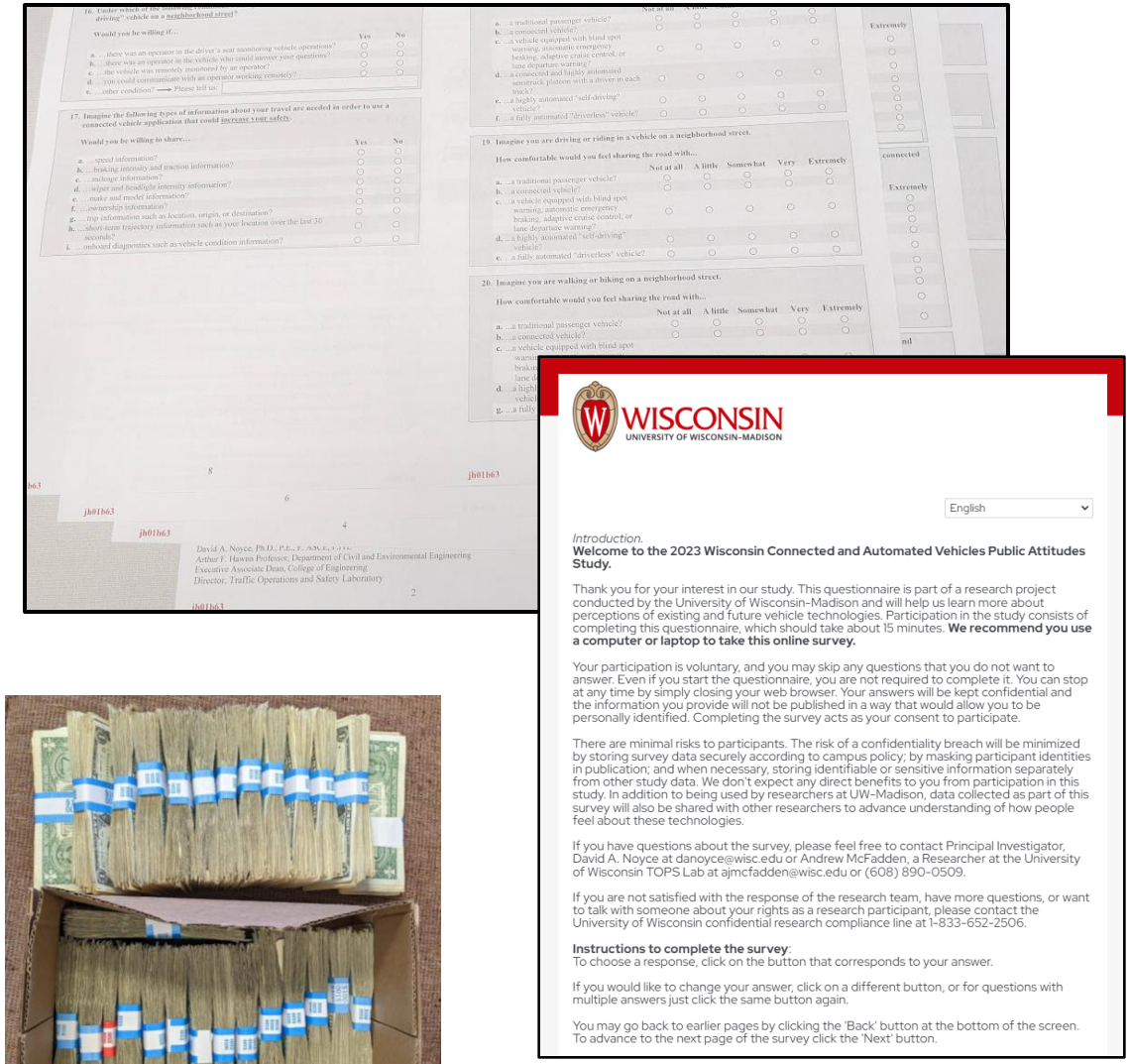
1. How do attitudes and perceptions* vary across sub-populations?
2. What can WisDOT do/change to respond to these attitudes and perceptions?

*These attitudes and perceptions include the following:

- Acceptance of testing
- Willingness to use
- Understanding of technology
- Type of vehicle
- Benefits
- Drawbacks
- Barriers

Survey Development

- Paper and online options
- Two Recruitments:
  - Random
    - Sent to randomly selected households
  - Convenience
    - Sent via Social Media and DMV monitors
- Translated to Spanish
- 42 questions
- 184 items
- $1 Preincentive
- $10 if valid

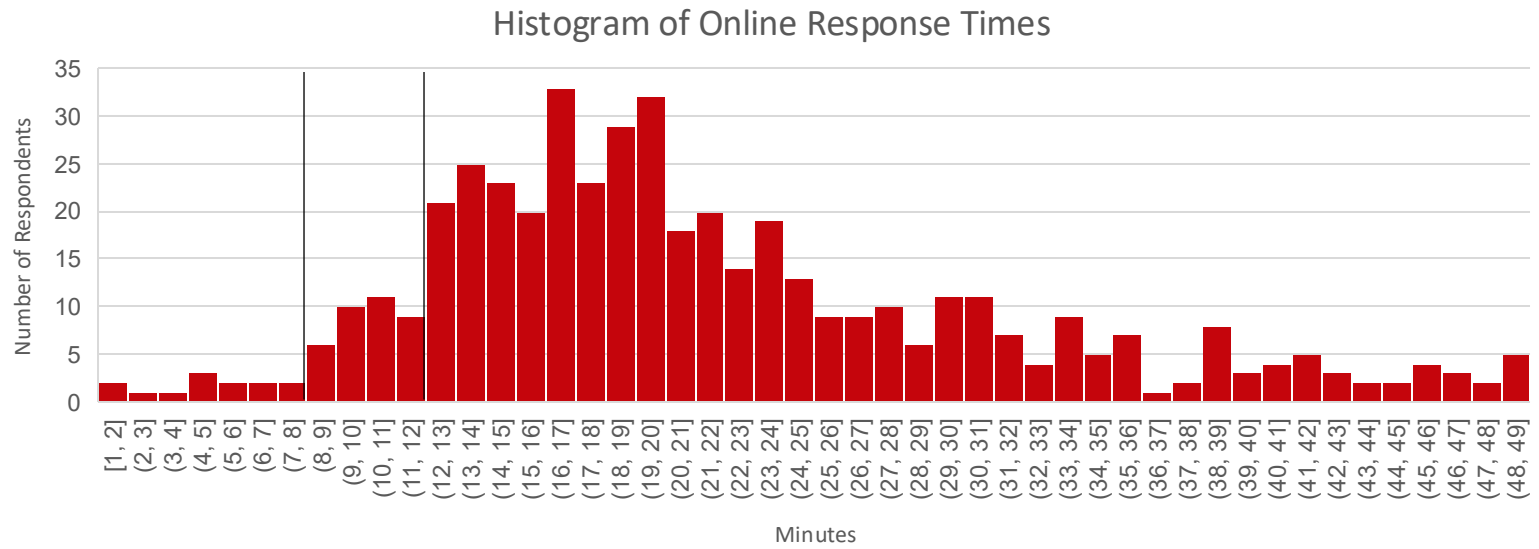


Survey Data Cleaning

- Flags for each question group and overall time taken were created
  - Used to screen respondents who answered:
    - very consistently
    - very quickly
- Based on flags - 9 respondents were considered invalid
- Threshold of up to 44 blank items set
- Based on missing responses - 29 respondents were considered invalid

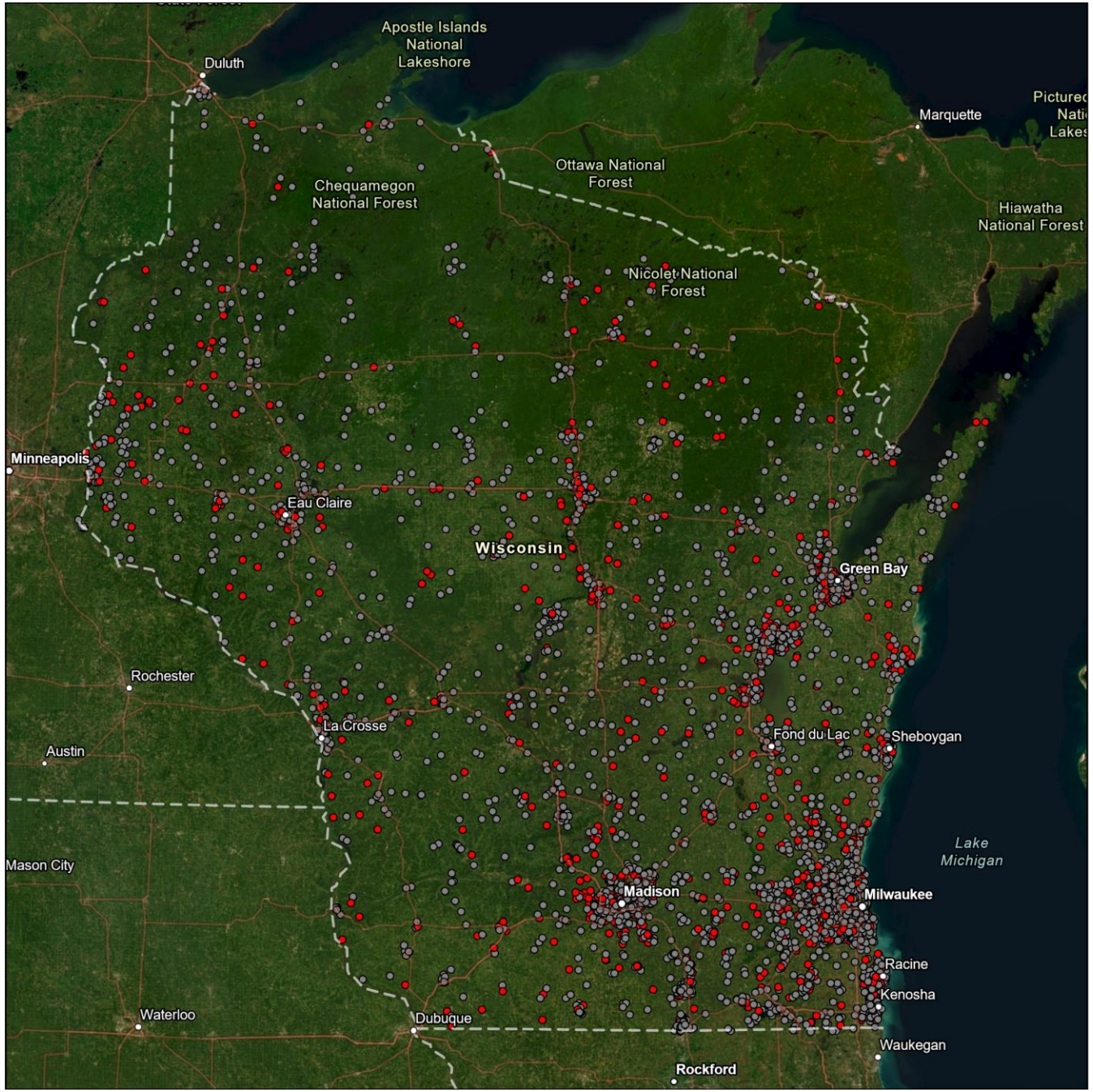
11. **How familiar are you with...**

	Not at all	A little	Somewhat	Very	Extremely
...connected vehicles?	○	○	○	●	○
...blind spot warning?	○	○	○	●	○
...anti-lock brakes?	○	○	○	●	○
...adaptive cruise control?	○	○	○	●	○
...automatic emergency braking?	○	○	○	●	○
...lane departure warning?	○	○	○	●	○
...highly-automated "self-driving" vehicles?	○	○	○	●	○
...fully-automated "driverless" vehicles?	○	○	○	●	○

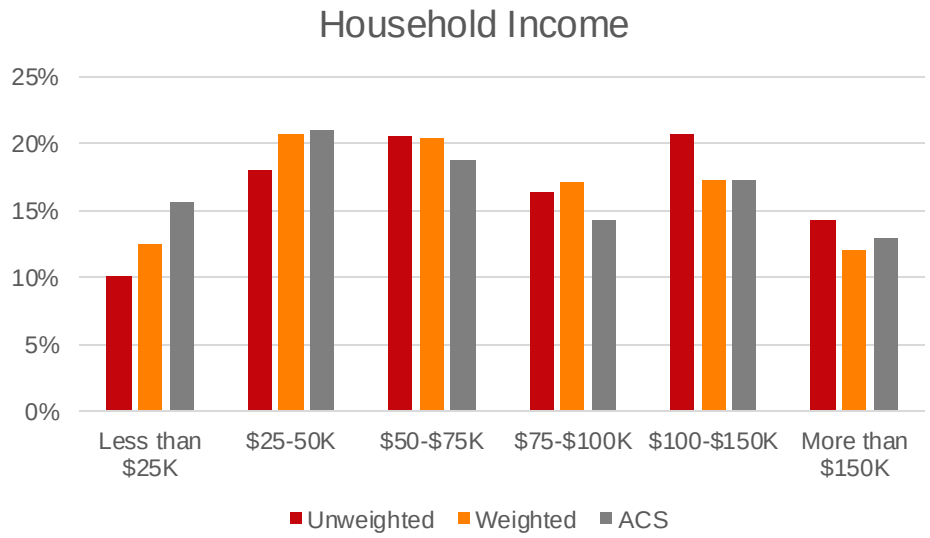


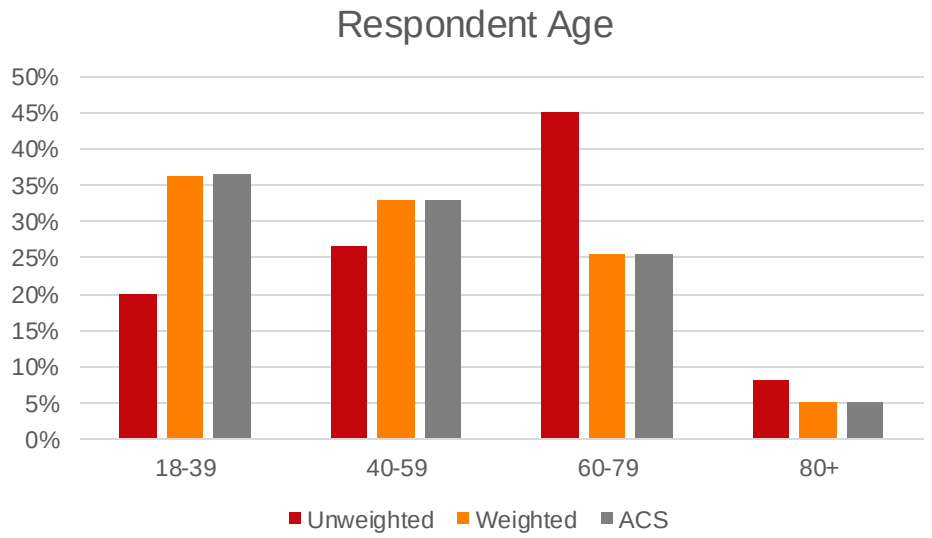
Study Sample

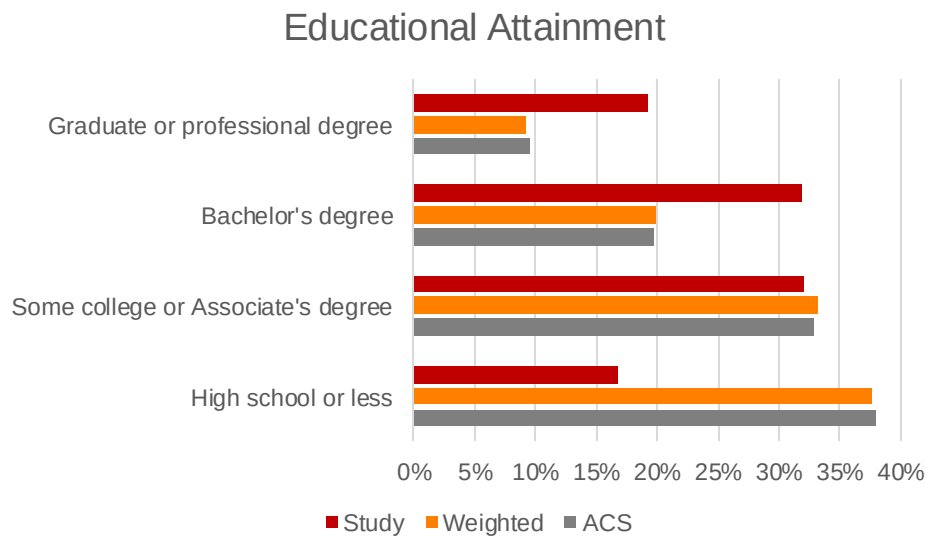
- 4300 Random Households
- 963 Total Responses
- 915 Valid Responses
- 21.3% Response Rate

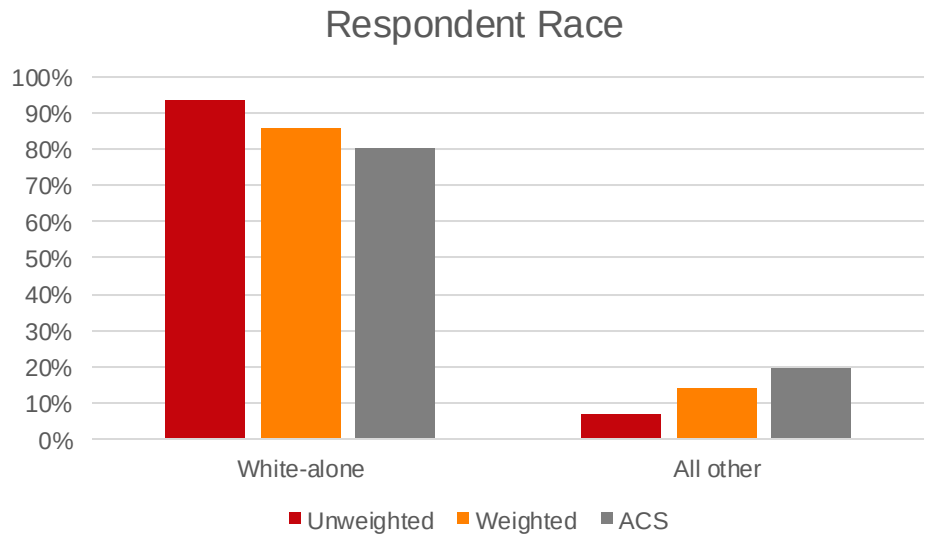


Respondents









Wisconsin CAV Attitudes Survey
Results

The following slides present the results of the data analysis addressing the project's first objective:

1. **How do attitudes and perceptions vary across sub-populations?**
   - **Acceptance of testing**
   - **Willingness to use**
   - **Understanding of technology**
   - **Type of vehicle**
   - **Benefits**
   - **Drawbacks**
   - **Barriers**

2. What can WisDOT do/change to respond to these attitudes and perceptions?

Definitions

Connected Vehicles - a vehicle using communication technologies to communicate with the driver, other cars on the road, other travelers such as people walking and biking, and roadway equipment such as traffic signals.

Highly Automated "Self-driving" Vehicle - a vehicle using an automated driving system that can fully drive the vehicle sometimes but still needs a backup driver.

Fully Automated "Driverless" Vehicle - a vehicle using an automated driving system that can fully drive the vehicle at all times.

Truck Platooning - linking of two or more trucks in convoy, using connected and automated vehicle technology. This allows the following vehicles to follow the lead vehicle with limited driver assistance.

Wisconsin CAV Attitudes Survey
Research Objectives

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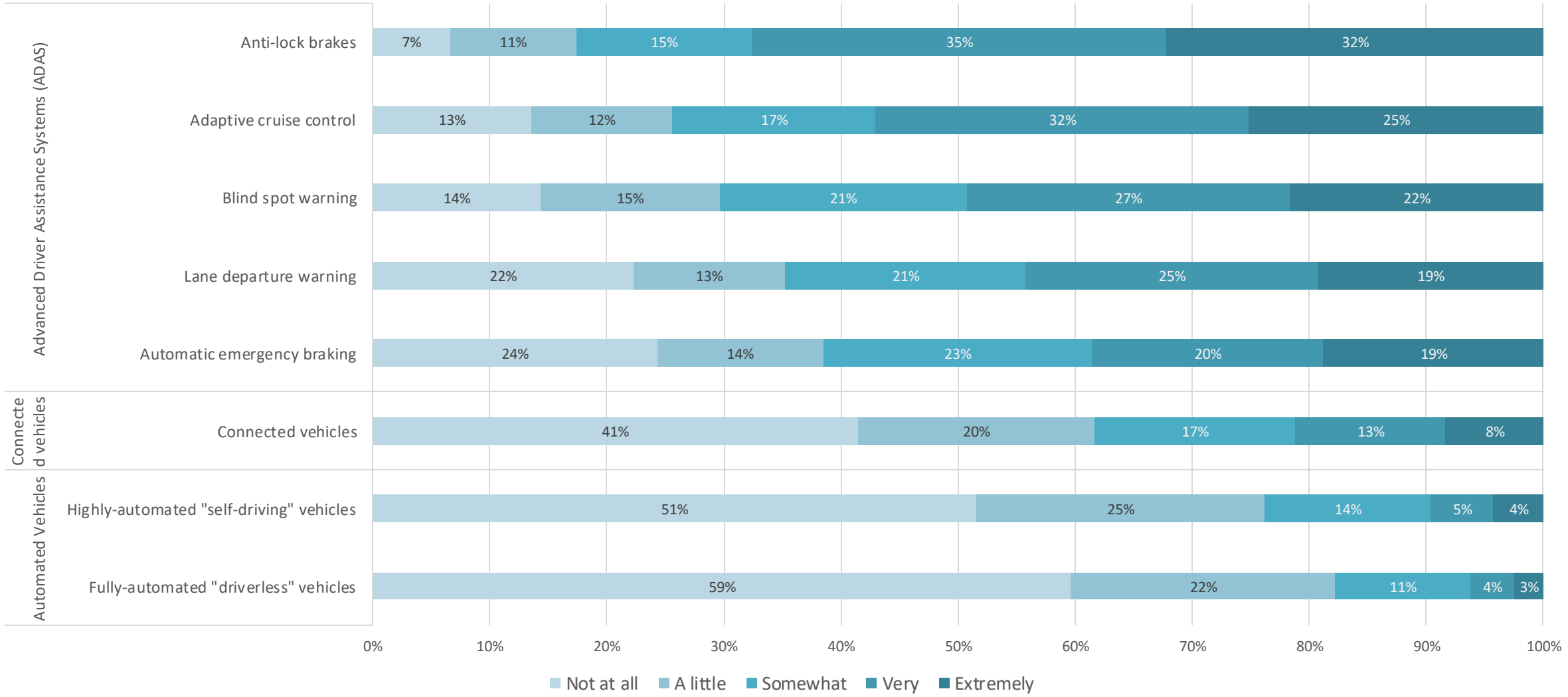
- **Understanding of technology**
- Type of vehicle
- Benefits
- Drawbacks
- Barriers

Familiarity Results

11. How familiar are you with…

	Not at all	A little	Somewhat	Very	Extremely
a. ...connected vehicles?	○	○	○	○	○
b. ...blind spot warning?	○	○	○	○	○
c. ...anti-lock brakes?	○	○	○	○	○
d. ...adaptive cruise control?	○	○	○	○	○
e. ...automatic emergency braking?	○	○	○	○	○
f. ...lane departure warning?	○	○	○	○	○
g. ...highly-automated "self-driving" vehicles?	○	○	○	○	○
h. ...fully-automated "driverless" vehicles?	○	○	○	○	○

Familiarity Results



Experience Results

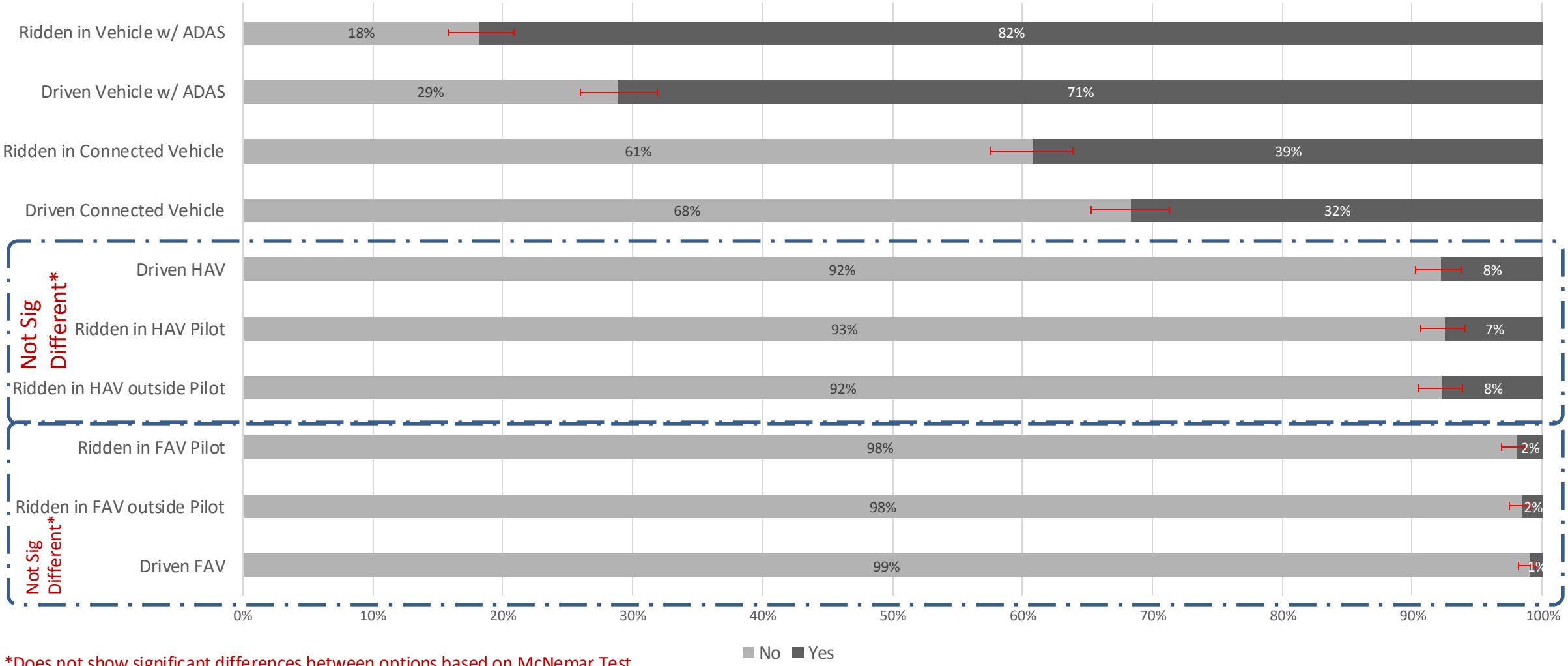
12. The next questions ask about what experience you have had with these kinds of vehicles.

	Yes	No
a. Have you ever driven a connected vehicle?	○	○
b. Have you ever ridden in a connected vehicle?	○	○
c. Have you ever driven a vehicle with at least one of the following features: blind spot warning, automatic emergency braking, adaptive cruise control, or lane departure warning?	○	○
d. Have you ever ridden in a vehicle with at least one of the following features: blind spot warning, automatic emergency braking, adaptive cruise control, or lane departure warning?	○	○

13. Please continue thinking about your personal experiences with these types of vehicles.

	Yes	No
a. Have you ever driven a highly automated vehicle?	○	○
b. Have you ever ridden in a highly automated "self-driving" vehicle during a demonstration or pilot?	○	○
c. Have you ever ridden in a highly automated "self-driving" vehicle outside of a demonstration or pilot?	○	○
d. Have you ever driven a fully automated "driverless" vehicle?	○	○
e. Have you ever ridden in a fully automated "driverless" vehicle during a demonstration or pilot?	○	○
f. Have you ever ridden in a fully automated "driverless" vehicle outside of a demonstration or pilot?	○	○

Experience Results



*Does not show significant differences between options based on McNemar Test

Wisconsin CAV Attitudes Survey
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Comfort Sharing the Road with Vehicle Technology by Road Type and Use

18. Imagine you are driving or riding in a vehicle on a highway with a speed limit of 65 mph or higher.
How comfortable would you feel sharing the road with...

	Not at all	A little	Somewhat	Very	Extremely
a. ...a traditional passenger vehicle?	○	○	○	○	○
b. ...a connected vehicle?	○	○	○	○	○
c. ...a vehicle equipped with blind spot warning, automatic emergency braking, adaptive cruise control, or lane departure warning?	○	○	○	○	○
d. ...a connected and highly automated semitruck platoon with a driver in each truck?	○	○	○	○	○
e. ...a highly automated "self-driving" vehicle?	○	○	○	○	○
f. ...a fully automated "driverless" vehicle?	○	○	○	○	○

19. Imagine you are driving or riding in a vehicle on a neighborhood street.

How comfortable would you feel sharing the road with...

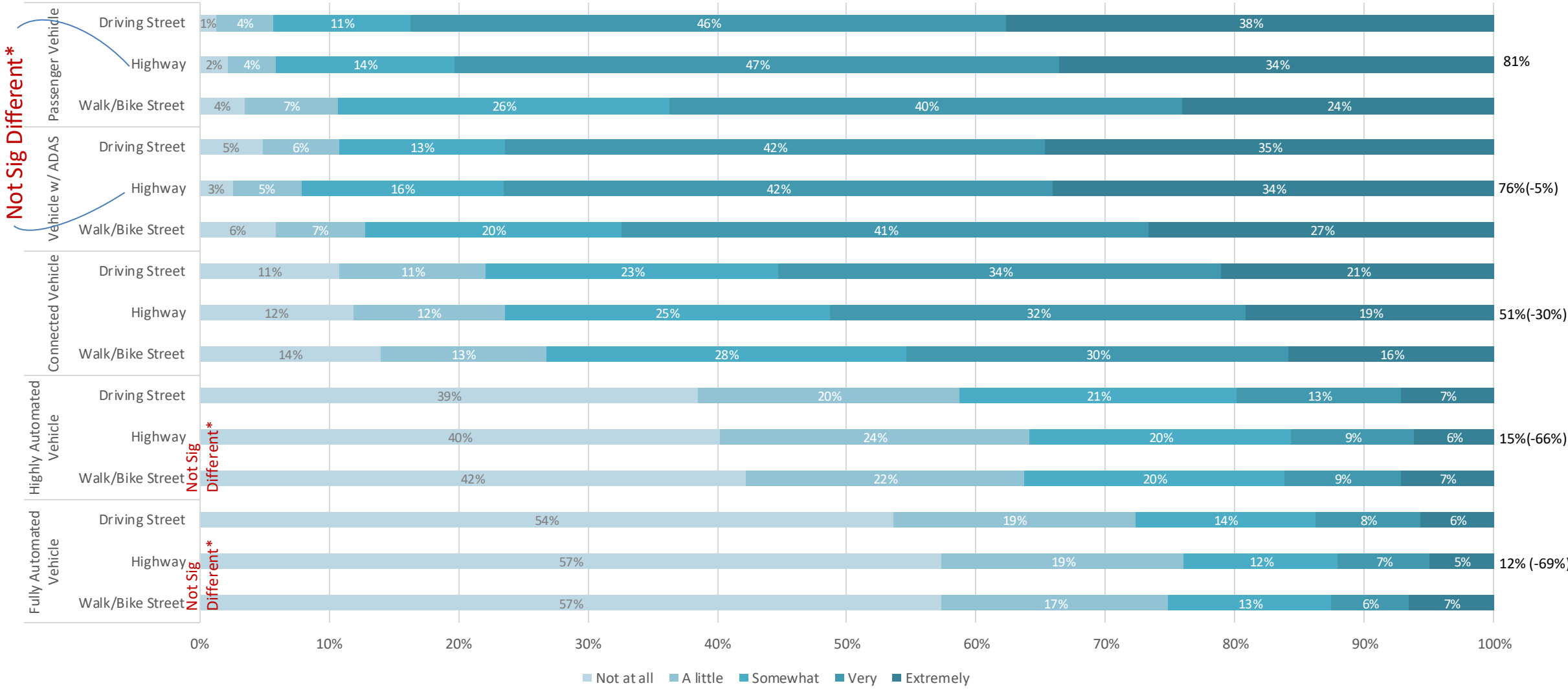
	Not at all	A little	Somewhat	Very	Extremely
a. ...a traditional passenger vehicle?	○	○	○	○	○
b. ...a connected vehicle?	○	○	○	○	○
c. ...a vehicle equipped with blind spot warning, automatic emergency braking, adaptive cruise control, or lane departure warning?	○	○	○	○	○
d. ...a highly automated "self-driving" vehicle?	○	○	○	○	○
e. ...a fully automated "driverless" vehicle?	○	○	○	○	○

20. Imagine you are walking or biking on a neighborhood street.

How comfortable would you feel sharing the road with...

	Not at all	A little	Somewhat	Very	Extremely
a. ...a traditional passenger vehicle?	○	○	○	○	○
b. ...a connected vehicle?	○	○	○	○	○
c. ...a vehicle equipped with blind spot warning, automatic emergency braking, adaptive cruise control, or lane departure warning?	○	○	○	○	○
d. ...a highly automated "self-driving" vehicle?	○	○	○	○	○
g. ...a fully automated "driverless" vehicle?	○	○	○	○	○

Comfort Sharing the Road with Vehicle Technology by Road Type and Use



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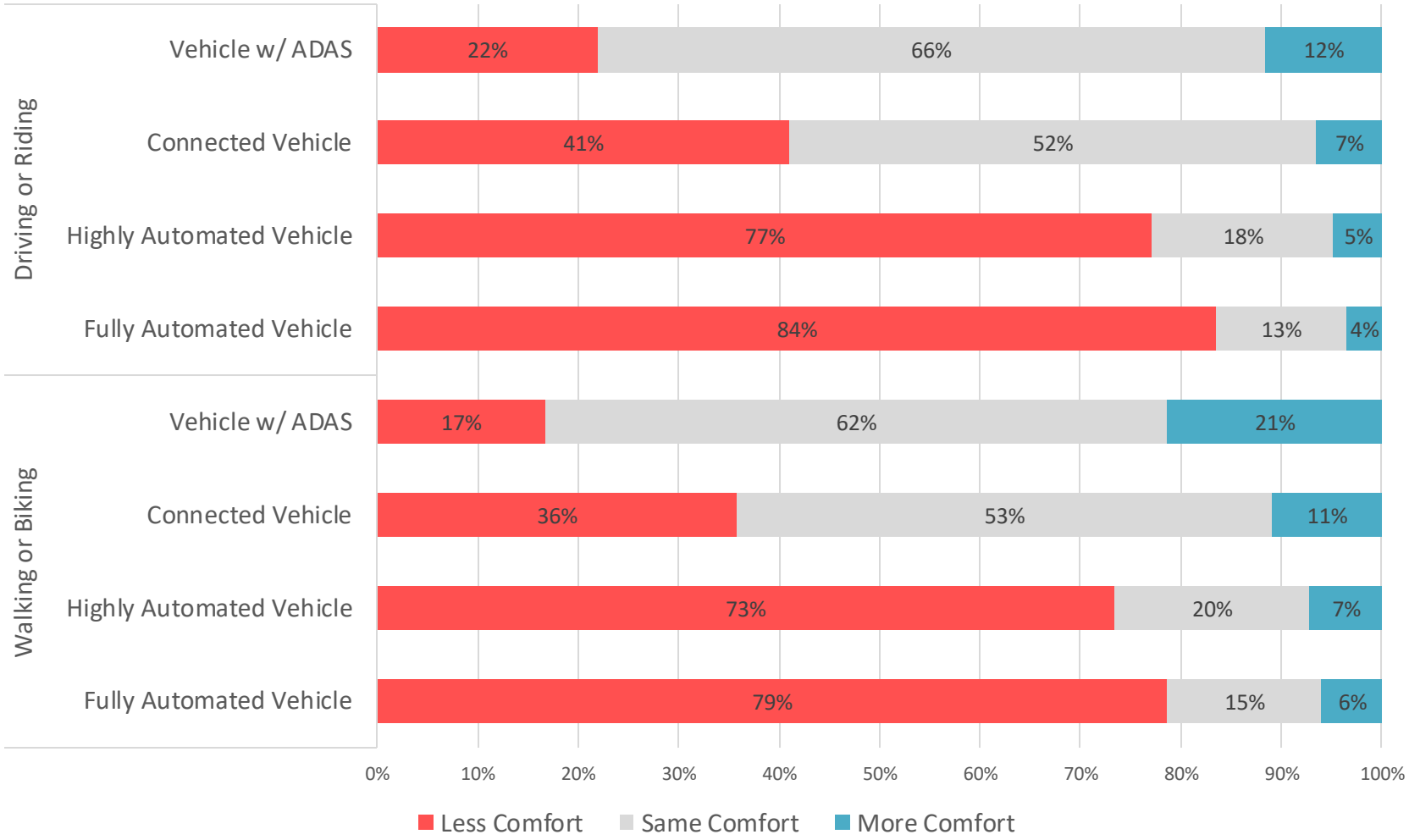
Comfort Sharing the Road with Vehicle Technology by Road Type and Use



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- **Willingness to use**
- Understanding of technology
- Type of vehicle
- Benefits
- Drawbacks
- Barriers

Willingness to Use Results

14. If it were currently available to you, how willing would you be to use…

	Not at all	A little	Somewhat	Very	Extremely
a. …a connected vehicle?	○	○	○	○	○
b. …a vehicle equipped with blind spot warning, automatic emergency braking, adaptive cruise control, or lane departure warning?	○	○	○	○	○
c. …a connected and highly automated semitruck platoon with a driver in each truck to ship a package on a highway?	○	○	○	○	○
d. …a highly automated "self-driving" shuttle?	○	○	○	○	○
e. …a highly automated "self-driving" personal vehicle?	○	○	○	○	○
f. …a fully automated "driverless" shuttle?	○	○	○	○	○
g. …a fully automated "driverless" personal vehicle?	○	○	○	○	○
h. …a fully automated "driverless" delivery van?	○	○	○	○	○

Willingness to Use Results

*Does not show significant differences between options based on Wilcoxon Rank Sum Test

Willingness to Use by Condition Results

15. Under which of the following conditions would you be willing to use a highly automated "self-driving" vehicle on a highway with a speed limit of 65 mph or higher?

Would you be willing if…

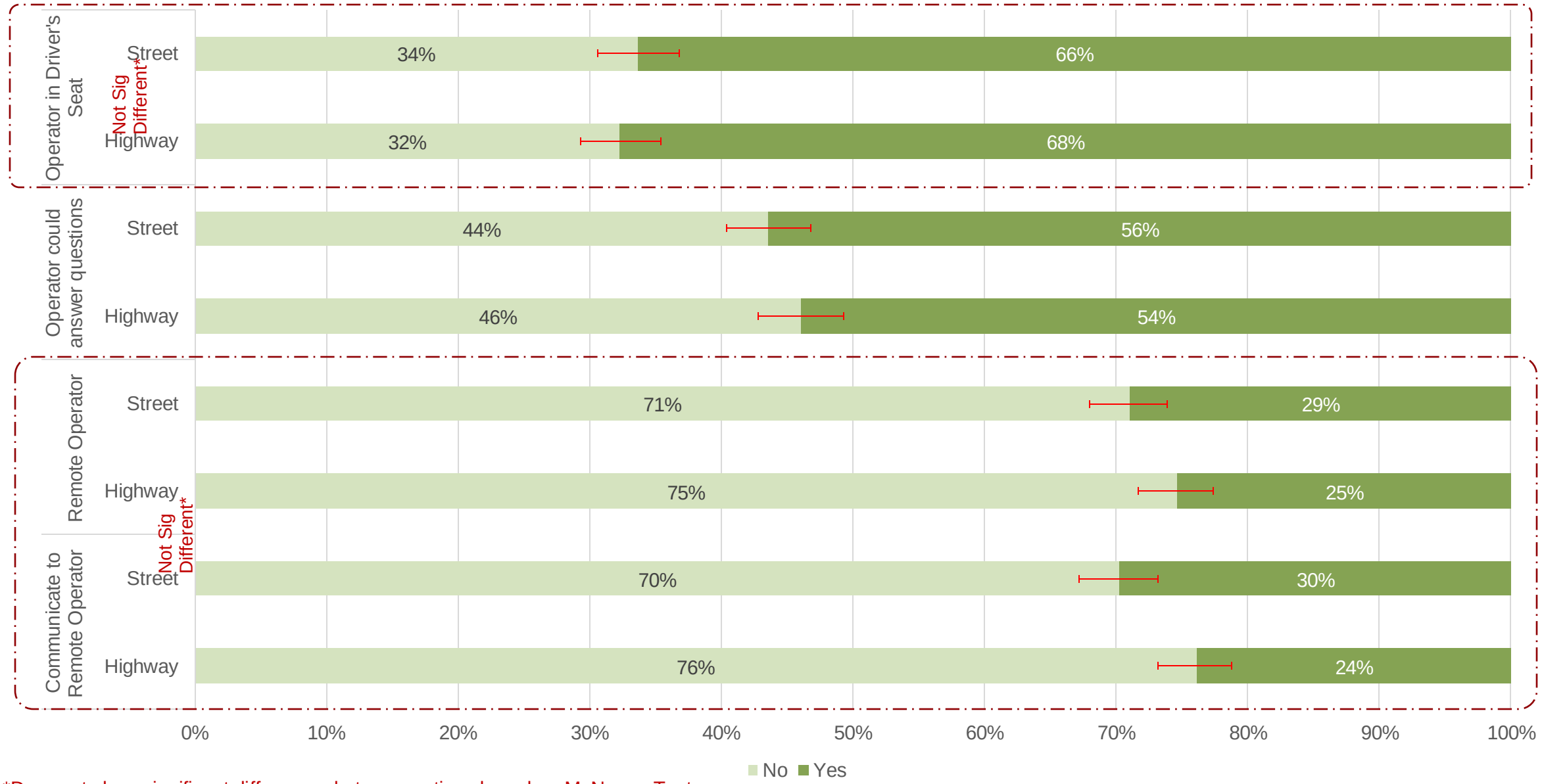
	Yes	No
a. …there was an operator in the driver's seat monitoring vehicle operations?	○	○
b. …there was an operator in the vehicle who could answer your questions?	○	○
c. …the vehicle was remotely monitored by an operator?	○	○
d. …you could communicate with an operator working remotely?	○	○
e. …other condition? → Please tell us:		

16. Under which of the following conditions would you be willing to use a highly automated "self-driving" vehicle on a neighborhood street?

Would you be willing if…

	Yes	No
a. …there was an operator in the driver's seat monitoring vehicle operations?	○	○
b. …there was an operator in the vehicle who could answer your questions?	○	○
c. …the vehicle was remotely monitored by an operator?	○	○
d. …you could communicate with an operator working remotely?	○	○
e. …other condition? → Please tell us:		

Willingness to Use by Condition Results



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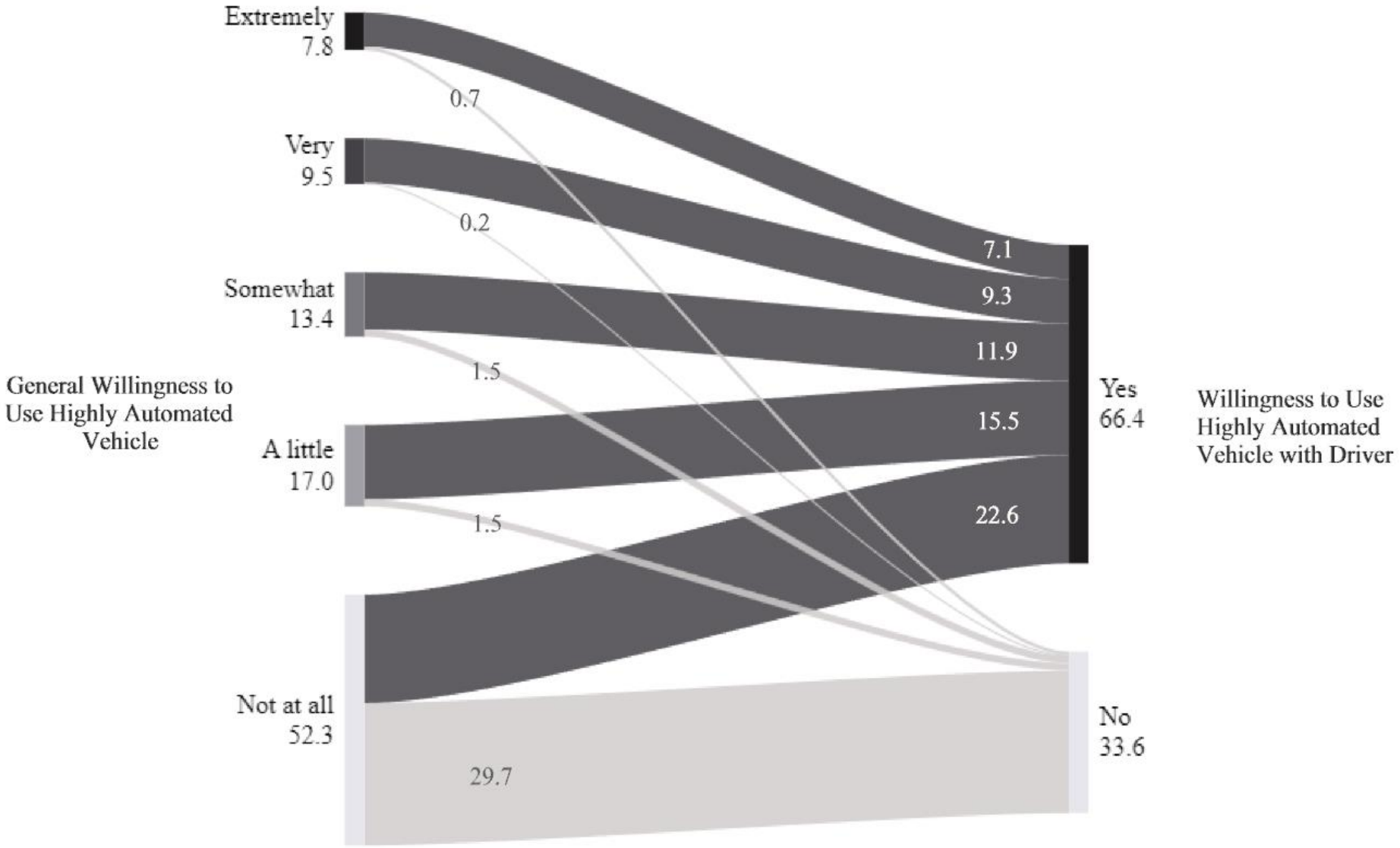
Willingness to Use Results



Willingness to Use Results

- Majority (66%) willing to use a vehicle with ADAS
- Willingness to use CV technology remains divided
- Willingness to use AV tech depends on the presence and location of the operator:
  - No information about the operator ~52% not at all willing to use AV
  - When an operator is in the vehicle that share drops to ~45%
  - When an operator is in the driver's seat that share drops to ~34%

Willingness to Share for Safety-Related CV Application

17. Imagine the following types of information about your travel are needed in order to use a connected vehicle application that could increase your safety.

Would you be willing to share…

	Yes	No
a. …speed information?	○	○
b. …braking intensity and traction information?	○	○
c. …mileage information?	○	○
d. …wiper and headlight intensity information?	○	○
e. …make and model information?	○	○
f. …ownership information?	○	○
g. …trip information such as location, origin, or destination?	○	○
h. …short-term trajectory information such as your location over the last 30 seconds?	○	○
i. …onboard diagnostics such as vehicle condition information?	○	○

Willingness to Share for Safety-Related CV Application

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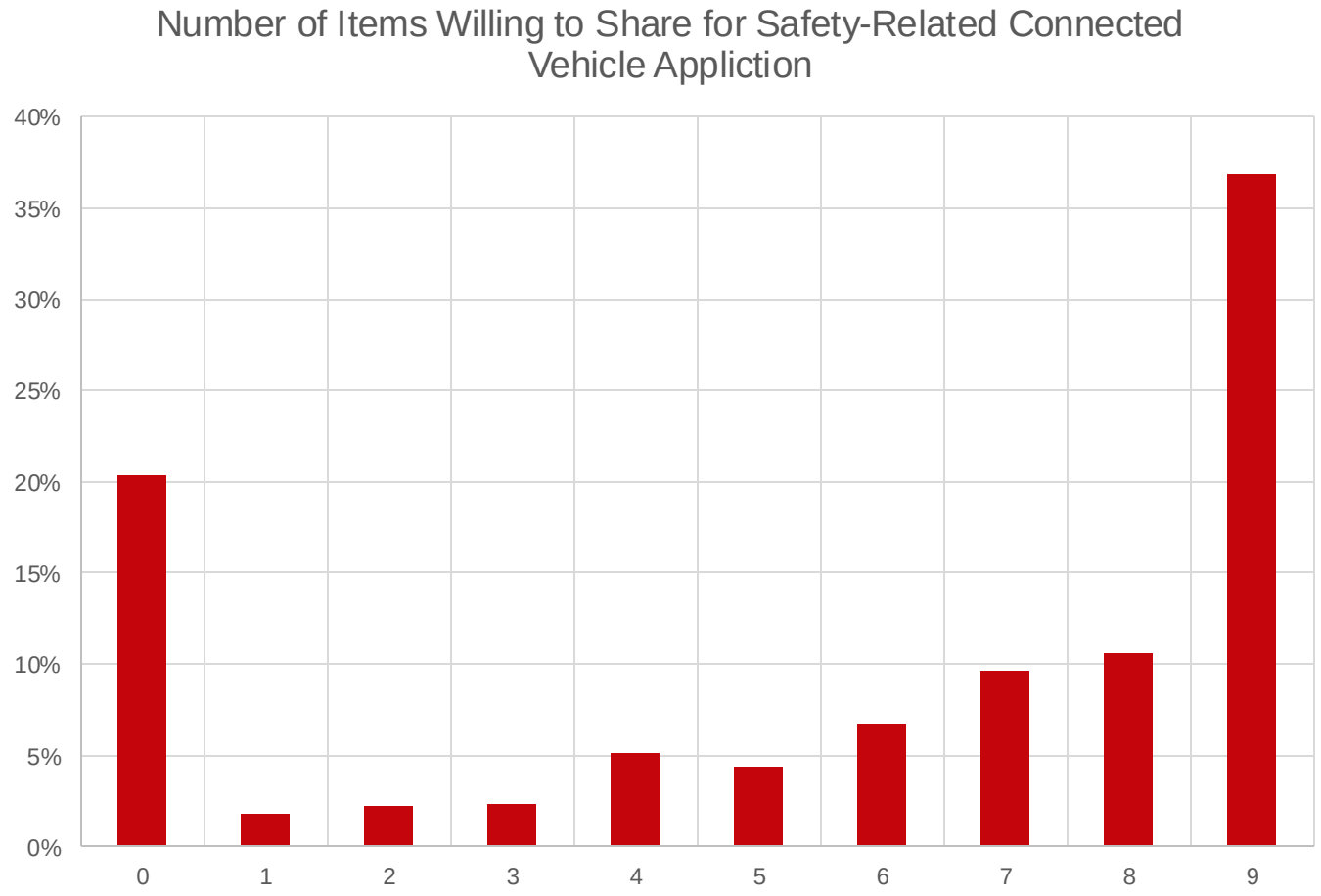
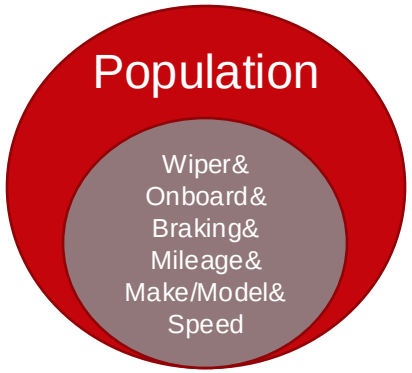
Willingness to Share for Safety-Related CV Application

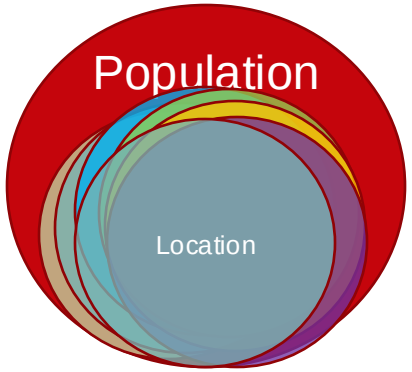


Willingness to Share for Safety-Related CV Application

- The majority (55%) of Wisconsinites are willing to share all of the following data for a safety-related CV application:
  - Wiper and headlight intensity
  - Onboard diagnostics
  - Braking intensity and traction
  - Mileage
  - Make and Model
  - Speed



- Short-term location information is important in making these applications work
- The majority of Wisconsinites are willing to share their location and the following items, independently:
  - Wiper and headlight intensity (56%)
  - Onboard diagnostics (56%)
  - Braking intensity and traction (55%)
  - Mileage (55%)
  - Make and Model (54%)
  - Speed (52%)



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Perceived Effect of Connected and Automated Vehicles on Issues

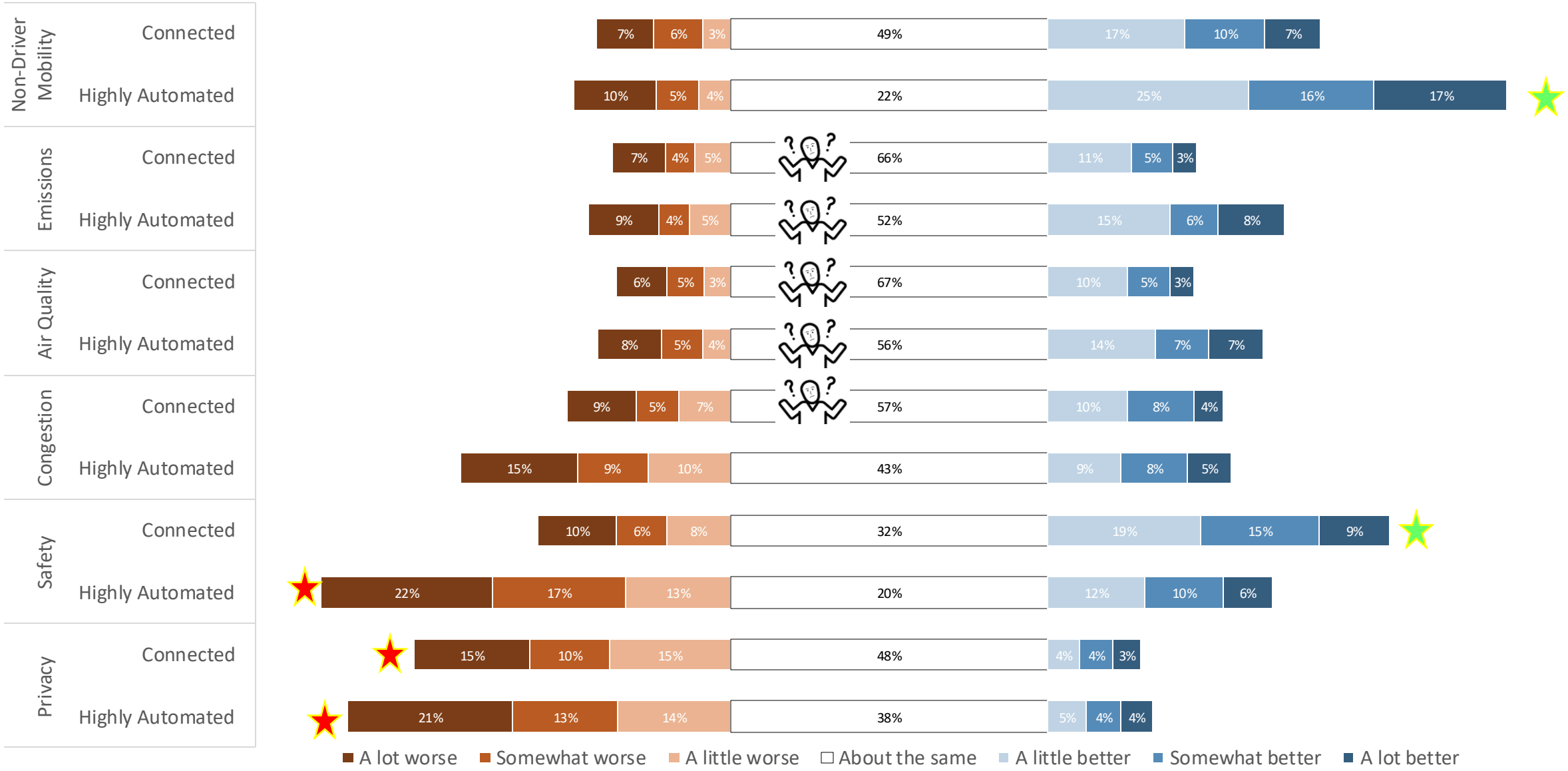
22. How much better or worse do you think automated "self-driving" vehicles will make each of the following issues?

	A lot worse	Somewhat worse	A little worse	About the same	A little better	Somewhat better	A lot better
a. Transportation safety	○	○	○	○	○	○	○
b. Mobility for non-drivers	○	○	○	○	○	○	○
c. Congestion	○	○	○	○	○	○	○
d. Air quality	○	○	○	○	○	○	○
e. Privacy	○	○	○	○	○	○	○
f. Greenhouse gas emissions	○	○	○	○	○	○	○

23. How much better or worse do you think connected vehicles will make each of the following issues?

	A lot worse	Somewhat worse	A little worse	About the same	A little better	Somewhat better	A lot better
a. Transportation safety	○	○	○	○	○	○	○
b. Mobility for non-drivers	○	○	○	○	○	○	○
c. Congestion	○	○	○	○	○	○	○
d. Air quality	○	○	○	○	○	○	○
e. Privacy	○	○	○	○	○	○	○
f. Greenhouse gas emissions	○	○	○	○	○	○	○

Perceived Effect of Connected and Automated Vehicles on Issues



Perceived Effect of Connected and Automated Vehicles on Issues

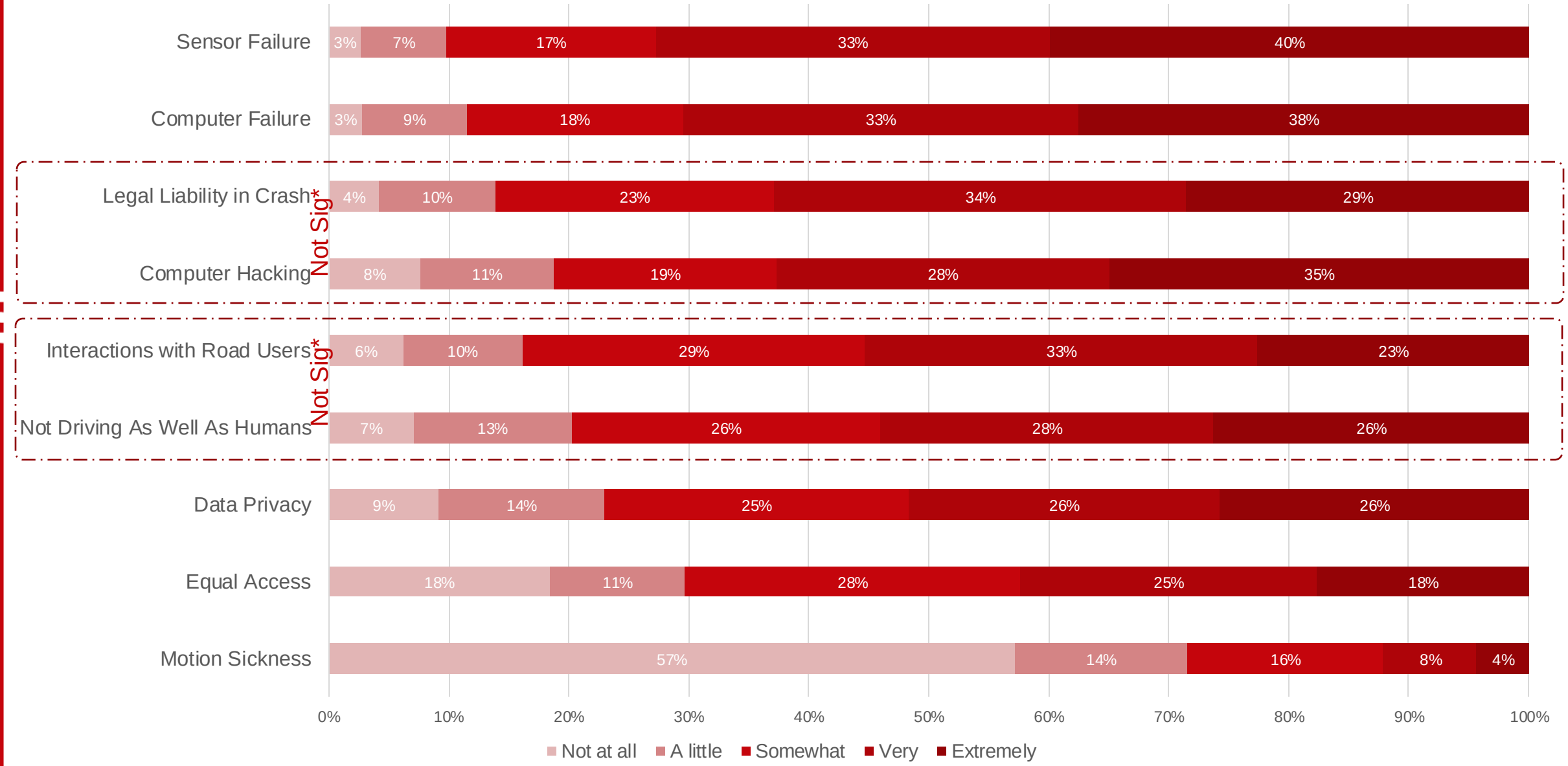
- Highest Positive Impact:
  - HAVs effect on non-driver mobility
    - No significant relationship between lack of vehicle and perception of impact
    - Minor, but significant negative relationship between unable to drive and perception of impact
  - CVs effect on traffic safety
- Highest Negative Impact:
  - CAVs effect on privacy
  - HAVs effect on traffic safety – **contrary to most other studies**
    - Several variables were associated with these perceptions:
      - Positive
        - Educational attainment, Tech readiness, Involvement in crash
      - Negative
        - Concern about vehicle not driving as well as humans, income
- Considerable uncertainty exists:
  - 10 of 12 items see option “about the same” as most common selected
  - 5 of 12 items see option “about the same” chosen by majority

Concerns about Connected and Automated Vehicles

24. How concerned are you about each of the following issues related to connected and automated vehicles?
Are you concerned about…

	Not at all	A little	Somewhat	Very	Extremely
a. …these vehicles not driving as well as human drivers?	○	○	○	○	○
b. …legal liability in case of a crash?	○	○	○	○	○
c. …data privacy such as location or destination tracking?	○	○	○	○	○
d. …interactions with other road users?	○	○	○	○	○
e. …equal access to these technologies?	○	○	○	○	○
f. …sensor equipment failure?	○	○	○	○	○
g. …vehicle computer system failure?	○	○	○	○	○
h. …vehicle computer hacking?	○	○	○	○	○
i. …motion sickness?	○	○	○	○	○
j. …other issues? → Please tell us:					

Concerns about Connected and Automated Vehicles

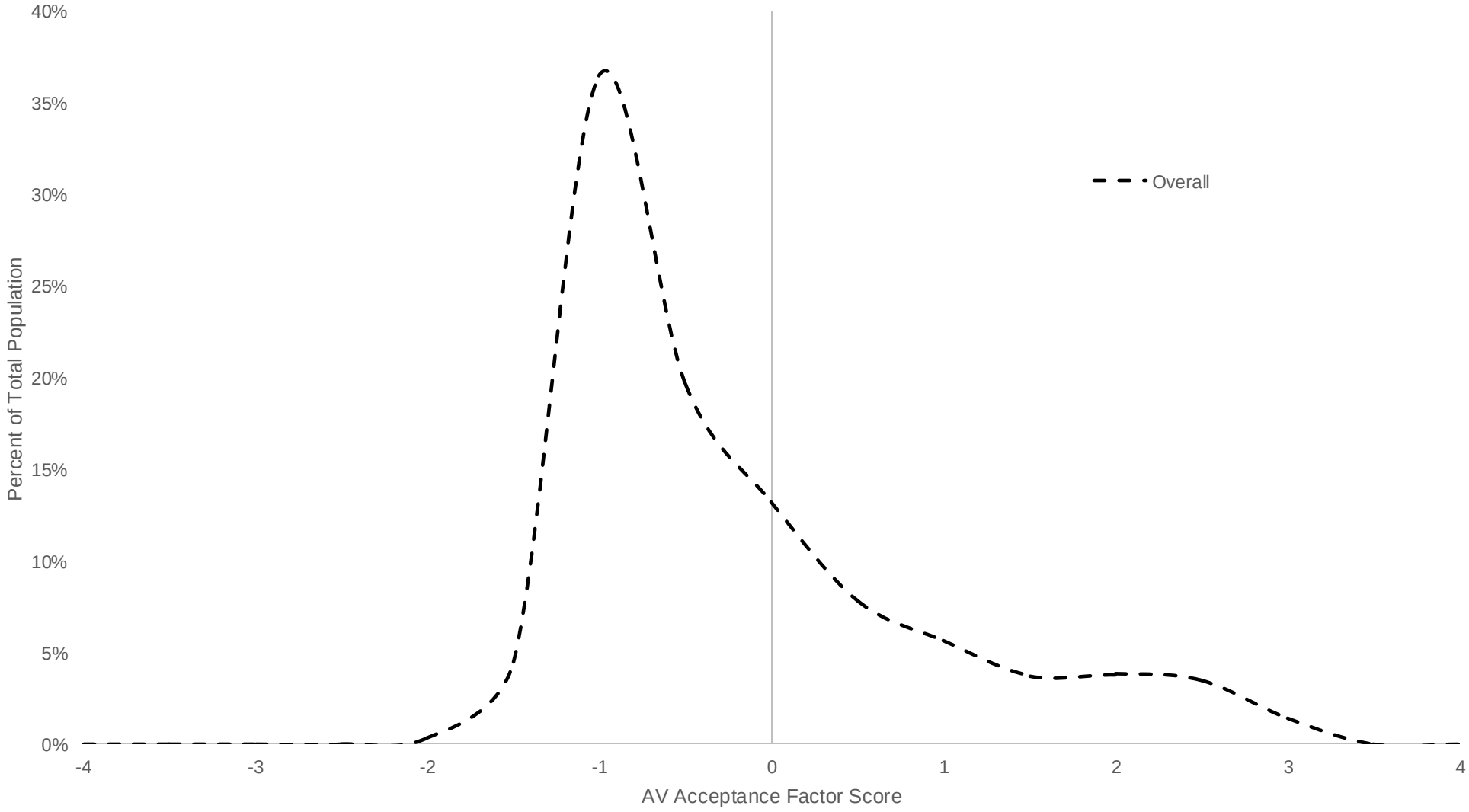


*Does not show significant differences between options based on Wilcoxon Rank Sum Test

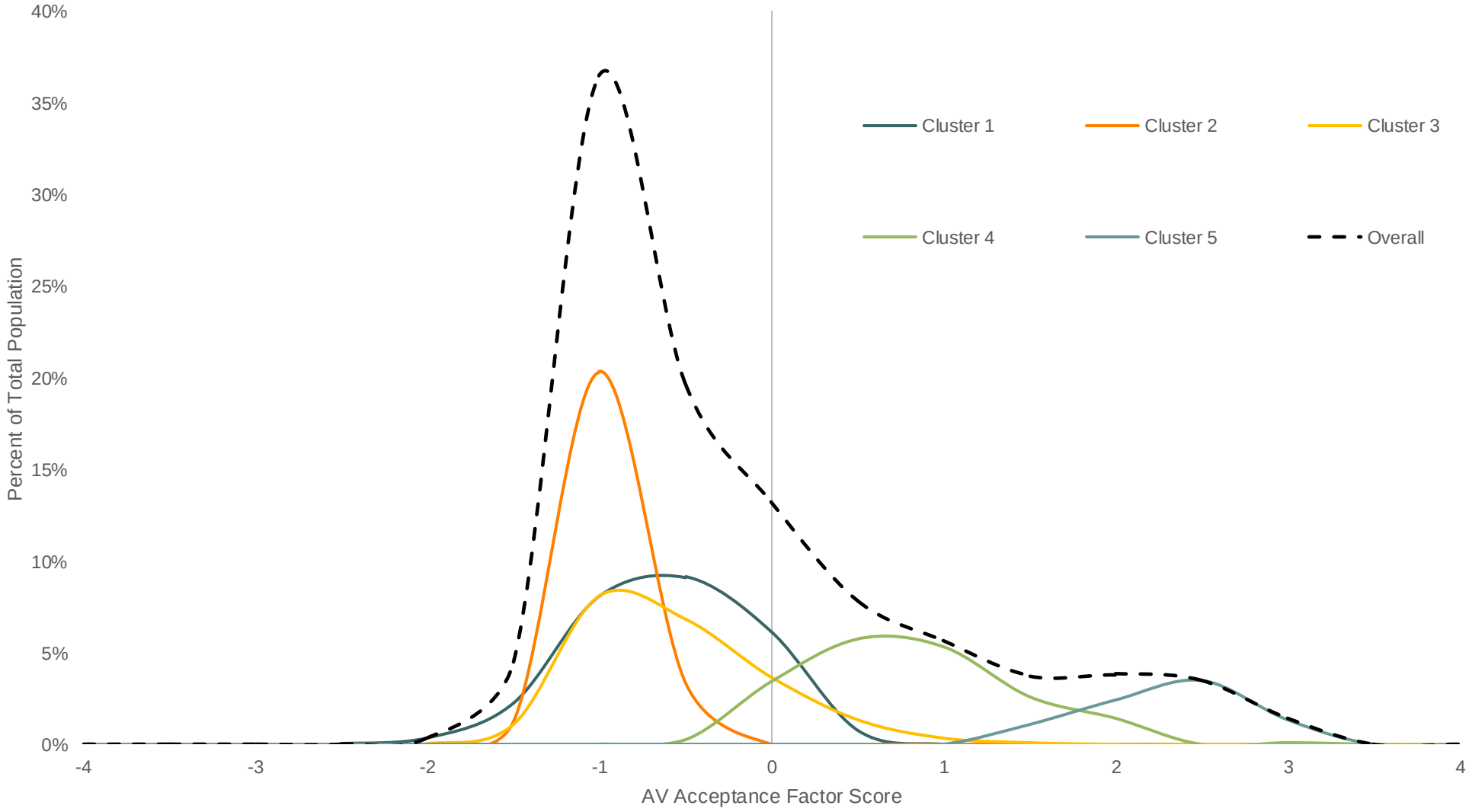
Latent Class Cluster Analysis

- A latent class cluster analysis (LCCA) was performed on the survey data to provide a grouping of Wisconsin residents by unique views across a range of CAV topics.
- Clusters include:
  - **Cluster 1** (27% of population)
    - 77% women
    - Very low benefits, low worry:
      - Low expectation of concerns
      - Lower expectation of benefits
  - **Cluster 2** (24% of population)
    - Primarily older, white, and rural
    - No effect, high worry:
      - No perceived effect from CAV
      - High expectation of concerns
  - **Cluster 3** (21% of population)
    - Primarily older in rural areas
    - Very low benefits, very high worry
      - Lowest expectations of benefits
      - Highest expectation of concerns
  - **Cluster 4** (20%)
    - Tend to be young and live in metro areas
    - Moderate interest, lower worry:
      - Moderate expectation of benefits
      - Lower expectation of concerns
  - **Cluster 5** (8%)
    - Primarily young, males, and urban
    - Highest interest, lowest worry

Latent Class Cluster Analysis



Latent Class Cluster Analysis



Wisconsin CAV Attitudes Survey
Results

The following slides present the results of the data analysis addressing the project's second objective:

1. How do attitudes and perceptions vary across sub-populations?
   - Acceptance of testing
   - Willingness to use
   - Understanding of technology
   - Type of vehicle
   - Benefits
   - Drawbacks
   - Barriers

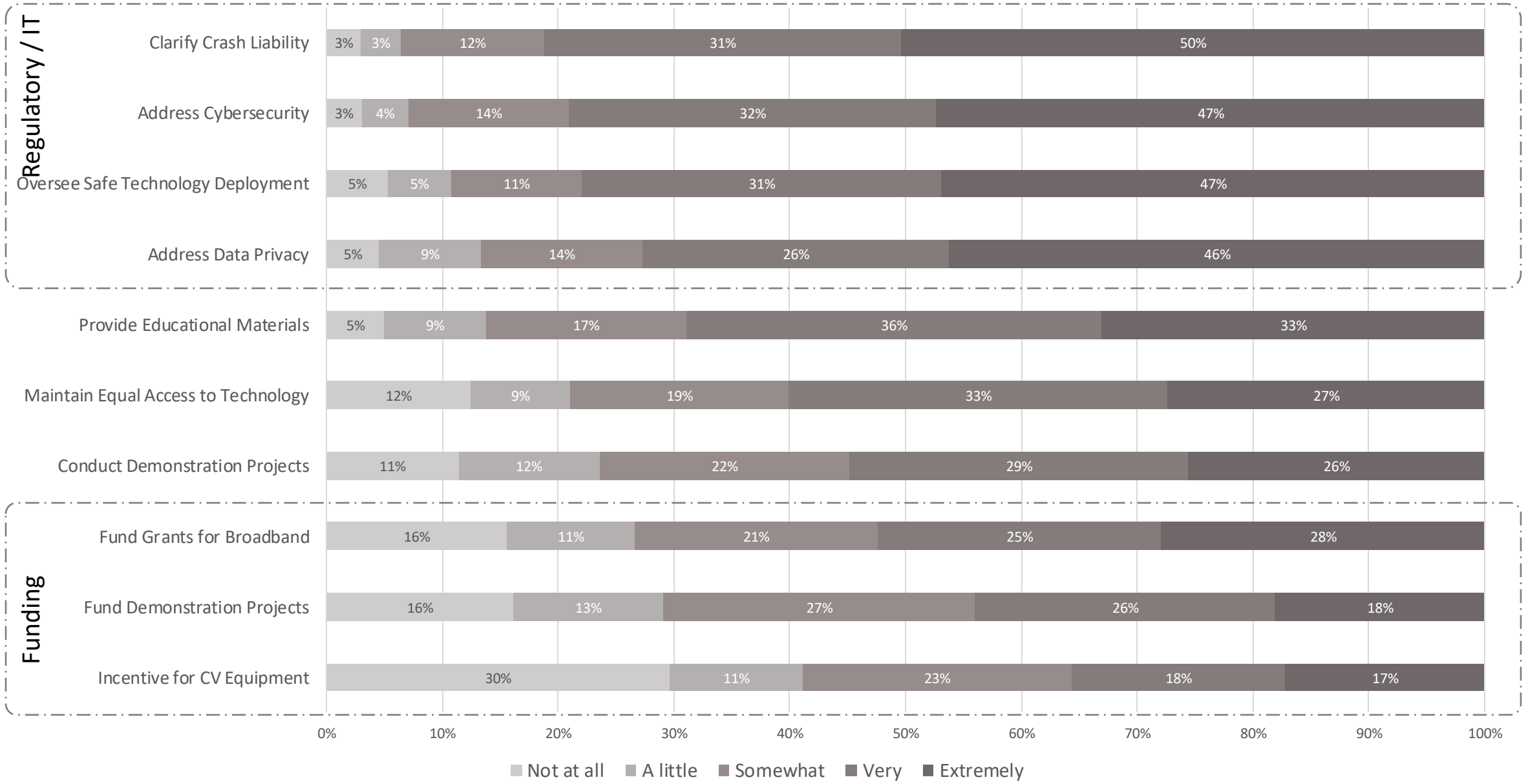
2. **What can WisDOT do/change to respond to these attitudes and perceptions?**

Role of Wisconsin State Government in CAV Technology

25. Next, we ask about your attitudes toward possible interventions meant to prepare for connected and automated vehicles.
How <u>important</u> is it for the Wisconsin State government to…

	Not at all	A little	Somewhat	Very	Extremely
a. …provide educational materials?	○	○	○	○	○
b. ...address cybersecurity concerns?	○	○	○	○	○
c. ...fund demonstration projects?	○	○	○	○	○
d. ...conduct demonstrations projects?	○	○	○	○	○
e. …oversee vehicle technology is deployed safely	○	○	○	○	○
f. …maintain equal access to technologies	○	○	○	○	○
g. ...address data privacy concerns?	○	○	○	○	○
h. ...clarify liability in the event of a crash?	○	○	○	○	○
i. ...fund grants for increased broadband connectivity?	○	○	○	○	○
j. …offer money back for purchasing connected vehicle equipment?	○	○	○	○	○

Role of Wisconsin State Government in CAV Technology



Role of Wisconsin State Government in CAV Technology

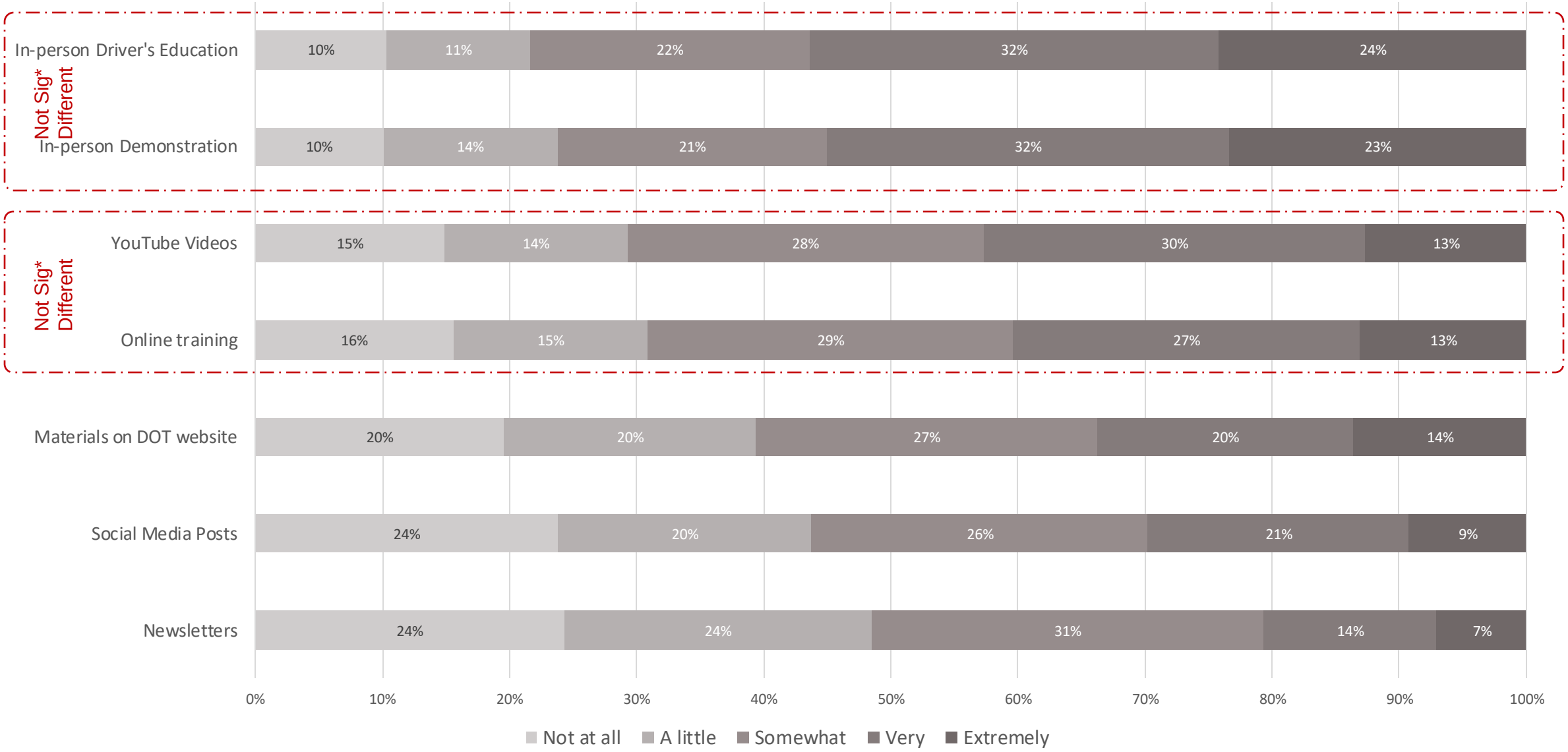
- **Regulatory / IT state actions** were deemed most important with the following shares noting very to extremely important:
  - **Clarify crash liability** (81%)
  - **Address cybersecurity** (79%)
  - **Oversee safe technology deployment** (78%)
  - **Address data privacy** (72%)
- Strong support for all actions

Helpfulness of Ways to Learn about CAV Technology

26. How helpful would each of the following be to help you learn more about connected and automated vehicles?

	Not at all	A little	Somewhat	Very	Extremely
a. Materials posted on State Department of Transportation website	○	○	○	○	○
b. YouTube videos	○	○	○	○	○
c. Social media posts	○	○	○	○	○
d. Online training	○	○	○	○	○
e. In-person driver's education training	○	○	○	○	○
f. In-person demonstration	○	○	○	○	○
g. Newsletters	○	○	○	○	○
h. Other ways. → Please tell us:					

Helpfulness of Ways to Learn about CAV Technology



*Does not show significant differences between options based on Wilcoxon Rank Sum Test

Helpfulness of Ways to Learn about CAV Technology

- **In-person demonstrations and education** deemed most helpful with 56% reporting very to extremely helpful
- **Online options** were also considered helpful
  - Share reporting very to extremely helpful:
    - **YouTube videos and online training** (~42%)
    - **Materials on the DOT website** (34%)
    - **Social media posts** (30%)
  - Extent of helpfulness varied significantly by age group (18-59, 60+) for:
    - **YouTube videos**
    - **Social media posts**

Next Steps

How will WisDOT use this information?

1. Incorporate into our ***CAV Strategic Work Plan***
    - Clarify crash liability
    - Address cybersecurity
    - Oversee safe technology deployment
    - Address data privacy
2. Incorporate into the ***CAV Technology Communications and Outreach Strategy***
    - Demonstrations

Refine information needs and messages for:

- **General Audiences**
- Local Government Officials
- State and Federal Policy Makers
- Law Enforcement and First Responders
- Business and Academic Developers
- Business Users

Next Steps

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How can you learn more?

- Contact us
- UW-Madison will be making an anonymized dataset public this Fall
  - **Join the mailing list** for more information
- Check out WisDOT's CAV website

wisconsindot.gov/cav

bit.ly/WI-CAV-Survey