USERS' PERCEPTIONS AND ATTITUDES TOWARD AUTONOMOUS VEHICLE TECHNOLOGIES AFTER SIMULATION EXPOSURE – A STUDY ACROSS THE LIFESPAN

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THE UNIVERSITY OF ALABAMA AT BIRMINGHAM

STRIDE
Southeastern Transportation Research, Innovation, Development and Education Center

INTRODUCTION

- Autonomous vehicles (AV) will have significant impacts on drivers among different age groups
- Previous studies suggest age is an important indicator for acceptance of autonomous vehicles.
- Recent perceptions are measured by surveys only.
- It is important to expose study participants to live experience of AV technology and understand its impact on the acceptance of AV technology across the lifespan.

OBJECTIVES

- Quantify the young (n= 34), middle-age (n=17), and older (n=50) adults' perceptions of AVs.

- Determine if any differences existed before and after exposure, by age group, and by gender.

HYPOTHESES

1. Participants would demonstrate an increase in *Intention to Use*, reduction in perceived *Barriers*, and increase in *Acceptance* of AV technology after exposure to the simulator (vs. pre-exposure)

2. Older drivers' perceptions would have the greatest magnitude of change (vs. middle-aged and younger adults)

3. Women participants would demonstrate more positive changes in acceptance of AV technology after exposure to the simulator (vs. men)

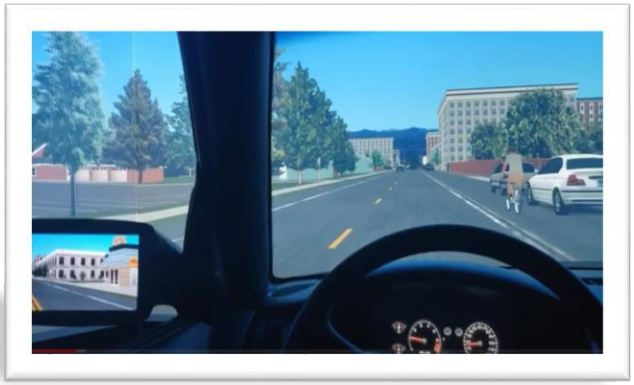
METHODOLOGY

- **Ethics:** IRB-01 Approved
- **Design:** Repeated measures of drivers' perceptions before and after being exposed to "driving" an AV simulator
- **Participants: (N=101)**

  Inclusion Criteria:
  - N= 34; 18-39 years old
  - N= 17; 40-64 years old
  - N= 50; 65 years old +
  - Valid driver's license

  Exclusion Criterion:
  - < 18 MoCA (mod-severe cog decline)
- **Equipment:**

  RTI High Fidelity Driving Simulator



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SIMULATOR

Smart House, Oak Hammock, Gainesville, FL

RTI simulator: Integrated into a full car cab with 7 HD visual channels creating a 180° field of view

- 3 forward, 2 side, 1 rearview, 1 virtual dash display car
- Operates at a 60Hz refresh rate for smooth graphics projected on 3 flat screens with high intensity projectors
- **Simulator Sickness Questionnaire**
- **Main drive**
  - autonomous drive (SAE Level 4)
  - ambient traffic interacting with other vehicles
  - realistic road infrastructure, buildings
  - low to moderate speed (15-35 mph)
  - suburban area

DATA COLLECTION

- **Visit 1: Baseline Measures**
  - Demographics
  - Trail-Making Test A & B
  - AV User Perception Survey (AVUPS)
  - Technology Acceptance Model
  - Technology Readiness Index 2.0
  - Driving Habits Questionnaire
  - Life Space Questionnaire

- **Visit 2: Post-Exposure Measures**
  - Simulator (SAE Level 4)
  - Motion Sickness Questionnaire
  - AVUPS

DATA MANAGEMENT

- **Data Collection:**
  - Trained Research Assistant
  - Research Electronic Data Capture (REDCap)

- **Data Processing and Analysis:**
  - R Studios and R version 4.0.2
  - $p \leq 0.05$

RESULTS: DEMOGRAPHIC

N = 101

Factor	Value	Frequency (%)
Age	Young	34(34%)
	Middle-aged	17(17%)
	Older	50(49%)
Gender	Male	45 (45%)
	Female	56 (55%)
Ethnicity	African-American or Black	10 (10%)
	Asian/Pacific Islander	18 (18%)
	Caucasian or White	64(63%)
	Hispanic or Latino	5 (5%)
	Multiracial	1 (1%)
	Other	3 (3%)
Education	High school graduate or equivalent	3 (8%)
	Some college credits	16 (16%)
	Trade/Technical/Vocational training	1 (1%)
	Associate's degree	11 (11%)
	Bachelor's degree	28 (28%)
	Master's degree	28 (28%)
	Doctorate/Professional degree	14(14%)
Marital Status	Single, never married	34 (34%)
	Married or domestic partnership	52 (51%)
	Widowed	7 (7%)
	Divorced	8 (8%)
Employment	Part-time	12 (12%)
	Full-time	15 (15%)
	Retired	47 (47%)
	Student	24 (24%)
	Unable to work	3 (3%)

RESULTS: BEFORE EXPOSURE TO THE SIMULATOR

Male vs. Female: A series of t-tests

AVUPS scores	Male vs. Female
Intention to Use	t (99) = -0.802, p = 0.4245
Barriers	t (99) = -0.026, p = 0.979
Acceptance	t (99) = -0.669, p = 0.505

Young vs. Middle-aged vs. Old: ANOVAs

AVUPS scores	Young vs. Middle vs. Older	Post-hoc
Intention to Use	**F (2,98) = 3.397, p = 0.037, η_G^2 = 0.065**	**Older > Middle: p = 0.031**
Barriers	F (2,98) = 1.418, p = 0.247, η_G^2 = 0.028	
Acceptance	**F (2,98) = 4.346, p = 0.016, η_G^2 = 0.081**	**Older > Middle: p = 0.011**

RESULTS: AFTER EXPOSURE TO THE SIMULATOR

Male vs. Female: A series of Wilcoxon tests

AVUPS scores	Male vs. Female
Intention to Use	p = 0.456
Barriers	**Female > Male: p = 0.022**
Acceptance	p = 0.356

Young vs. Middle-aged vs. Old: ANOVAs or ANCOVAs

AVUPS scores	Young vs. Middle vs. Older
Intention to Use	F (2,97) = 0.37, p = 0.692, η_G^2 = 0.008
Barriers	F (2,98) = 1.928, p = 0.151, η_G^2 = 0.038
Acceptance	F (2,97) = 0.529, p = 0.591, η_G^2 = 0.011

RESULTS: COMPARISON BEFORE & AFTER EXPOSURE

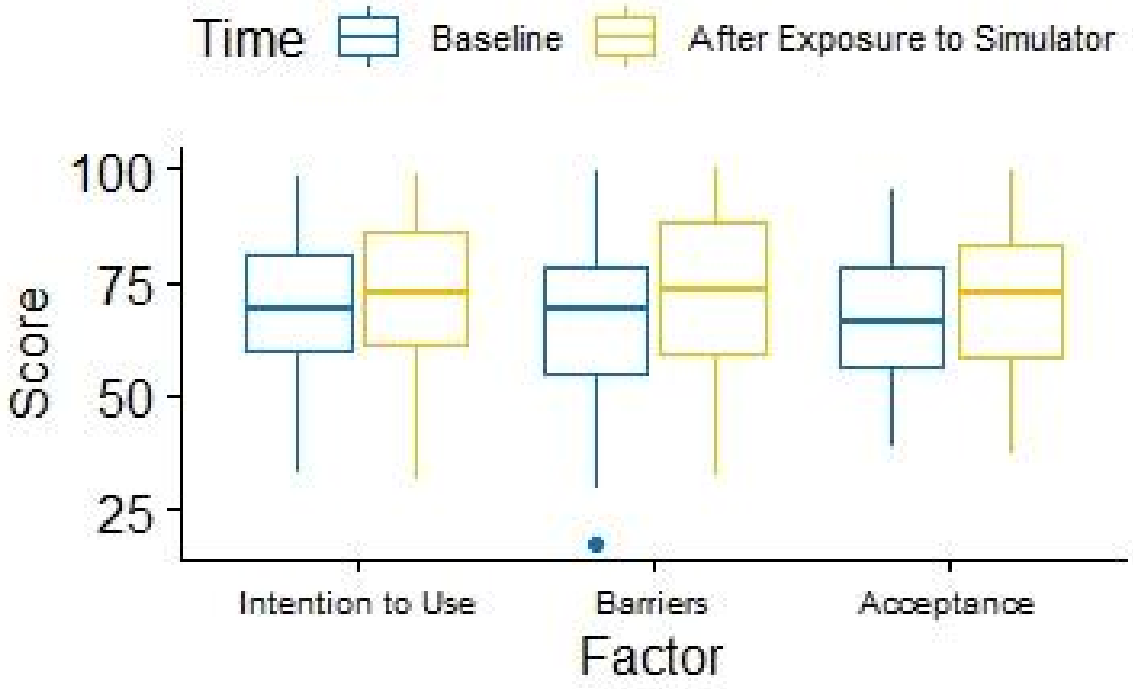
All participants combined (N=101)

AVUPS Scores	Before vs. after exposure to simulator
Intention to Use (Wilcoxon tests)	**p < 0.001**
Barriers (t-tests)	**t (100) = -3.540, p <0.001**
Acceptance (Wilcoxon tests)	**p < 0.001**

Exposure to the simulator results in higher scores for all three AVUPS scores compared to the baseline

RESULTS: COMPARISON BEFORE & AFTER EXPOSURE

AVUPS Domain Score Differences Before and After Exposure to the Simulator in AV Mode (N=101)



RESULTS: COMPARISON BEFORE & AFTER EXPOSURE

Differences based on age group

- The young group

AVUPS Scores	Before vs. After exposure to simulator
Intention to Use	t (33) = -1.316, p = 0.099
Barriers	t (33) = -1.166, p = 0.126
Acceptance (Wilcoxon tests)	p = 0.072

- The middle-aged group

AVUPS Scores	Before vs. After exposure to simulator
Intention to Use	t (16) = -1.543, p =0.071
Barriers	**t (16) = -1.936, p = 0.035(After > Before)**
Acceptance	t (16) = -1.831, p = 0.043

- The older group

AVUPS Scores	Before vs. After exposure to simulator
Intention to Use	**t (49) = -2.597, p = 0.006(After > Before)**
Barriers (Wilcoxon tests)	**p = 0.024(After > Before)**
Acceptance	**t (49) = -2.745, p = 0.004(After > Before)**

RESULTS: COMPARISON BEFORE & AFTER EXPOSURE

Differences based on gender group

Males (Wilcoxon tests):
No significant differences between baseline and after exposure to the simulator

Intention to Use: $p = 0.228$
Barriers: $p = 0.604$
Acceptance: $p = 0.579$

Females (t-tests):
The scores after exposure to the simulator are significantly higher than the baseline

Intention to Use: $t(55) = -4.026$, $p < 0.001$
Barriers: $t(55) = -4.541$, $p < 0.001$
Acceptance: $t(55) = -4.723$, $p < 0.001$

RESULTS: COMPARISON BEFORE & AFTER EXPOSURE

The percentage of score change based on age group

No difference among the young, middle-aged, and older group*:*

Intention to Use (ANOVA): $F(2,98) = 0.909$, $p = 0.406$, $\eta_g^2 = 0.018$

Barriers(Kruskal-Wallis tests): $X^2(2) = 2.366$, $p = 0.306$

Acceptance (Kruskal-Wallis tests) : $X^2(2) = 0.914$, $p = 0.633$

The percentage of score change based on gender group

The changes for female participants are greater than for males after exposure (Shapiro-Wilk tests):

Intention to Use: $p = 0.005$

Barriers: $p < 0.001$

Acceptance: $p < 0.001$

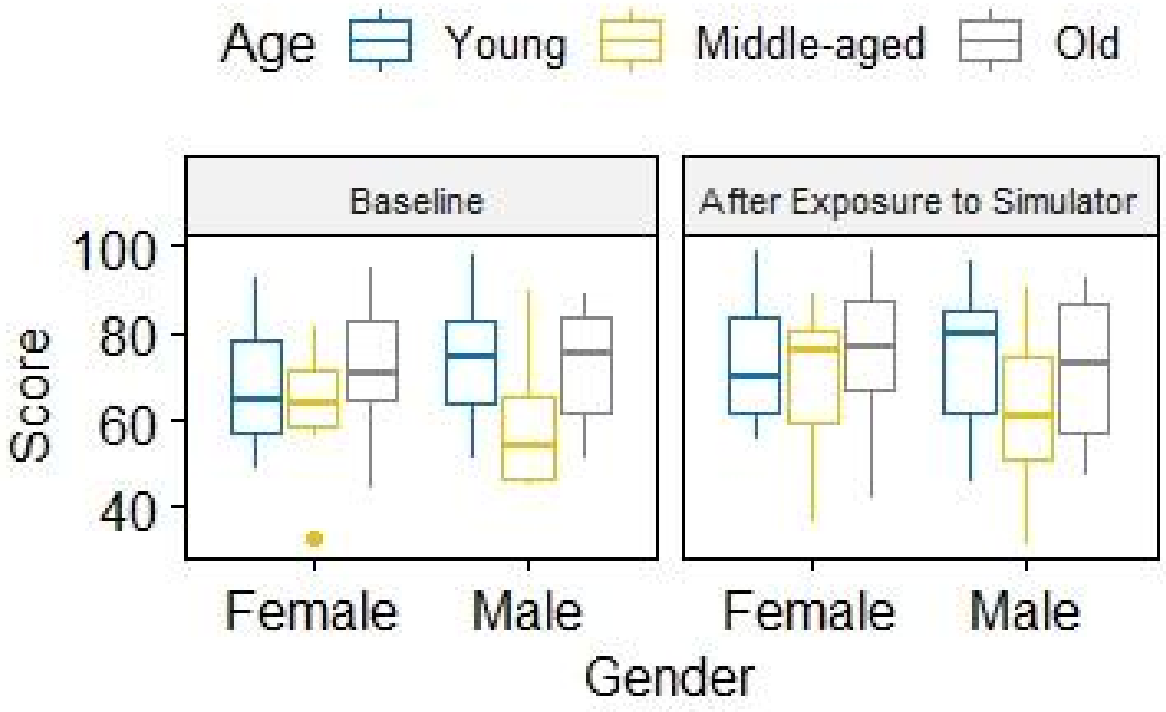
RESULTS: COMPARISON BEFORE & AFTER EXPOSURE

The three-way mixed ANOVA revealed that there are **no interactions between gender and age at the baseline and after exposure to the simulator:**

Intention to Use: $F(2,95) = 0.129$, $p = 0.879$, $\eta_g^2 < 0.001$
Barriers: $F(2,95) = 2.304$, $p = 0.105$, $\eta_g^2 = 0.007$
Acceptance: $F(2,95) = 0.856$, $p = 0.428$, $\eta_g^2 = 0.002$

RESULTS: COMPARISON BEFORE & AFTER EXPOSURE

Intention to Use by gender and age at the baseline and after exposure to the simulator

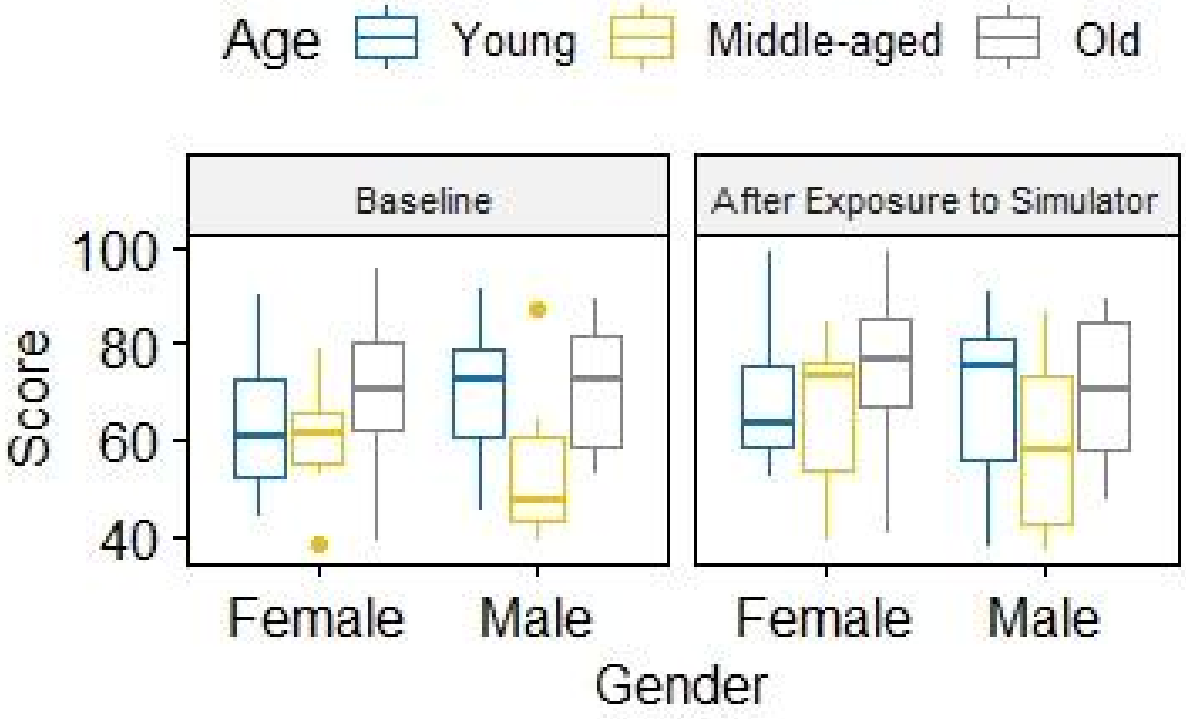


RESULTS: COMPARISON BEFORE & AFTER EXPOSURE

Barriers by gender and age
at the baseline and after exposure to the simulator

RESULTS: COMPARISON BEFORE & AFTER EXPOSURE

Acceptance by gender and age
at the baseline and after exposure to the simulator



CONCLUSIONS

- All 3 study hypotheses were supported
  - Intention to Use, Barriers, and Acceptance significantly improved after exposure to the AV simulator
  - Older drivers' perceptions show the greatest magnitude of change (vs. middle-aged and younger adults) after exposure to the AV simulator
  - Women demonstrate more positive changes in acceptance of AV technology after exposure to the technology (vs. men)
- Gender differences in the context of AV technology perceptions vary by age, and the gender-age impacts must be further examined
- Lived experiences via exposure to "driving" a simulator in autonomous mode can increase user acceptance and reduce perceived barriers pertaining to AV technology

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Stakeholders

- Transdev
- City of Gainesville
- Oak Hammock Residential Community
- Rotary Clubs Gainesville
- UF Transportation Institute
- FDOT
- ALDOT
- FL Safe Mobility for Life Coalition

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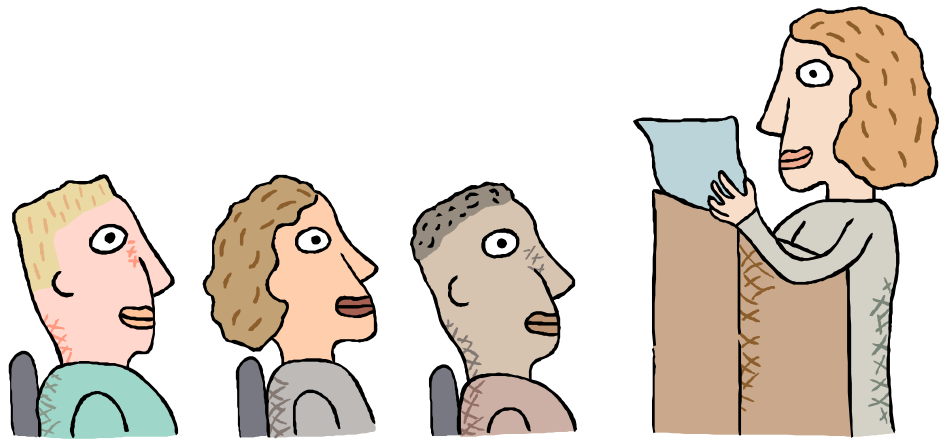
QUESTIONS AND COMMENTS



THANK YOU