

# How Do Different Non-Driving Related Tasks Affect Taking Back Control in Automated Vehicles?

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## Introduction

Automated vehicle technology will soon allow drivers to reclaim driving time and engage in tasks or activities that are currently not possible to perform while driving.

### LEVELS OF AUTONOMOUS DRIVING

0	No Driving Automation.
1	The vehicle has one driver assistance feature.
2	The vehicle can perform steering and acceleration.
3	The vehicle can drive with some driver assistance.
4	The vehicle can drive under most conditions.
5	The vehicle drives under all conditions.

Figure 1: Levels of Autonomous Driving

### Problem

How can we best support drivers when they are faced with situations where they must quickly stop their personal task and safely resume manual driving?

**Objective:** Investigate the drivers' takeover process to understand how texting interferes with takeovers in conditionally automated vehicles.

## Data Collection



Figure 4: Participant Wearing Eye-Tracker and Texting During Automated Driving

### Outcomes

- 17 Participants
- 102 Trial Drives
- 232 Takeovers Analyzed

### Pupil Detection



Figure 5: Pupil Detection With Eye-Tracker

### Gaze Tracking: Driving and Texting

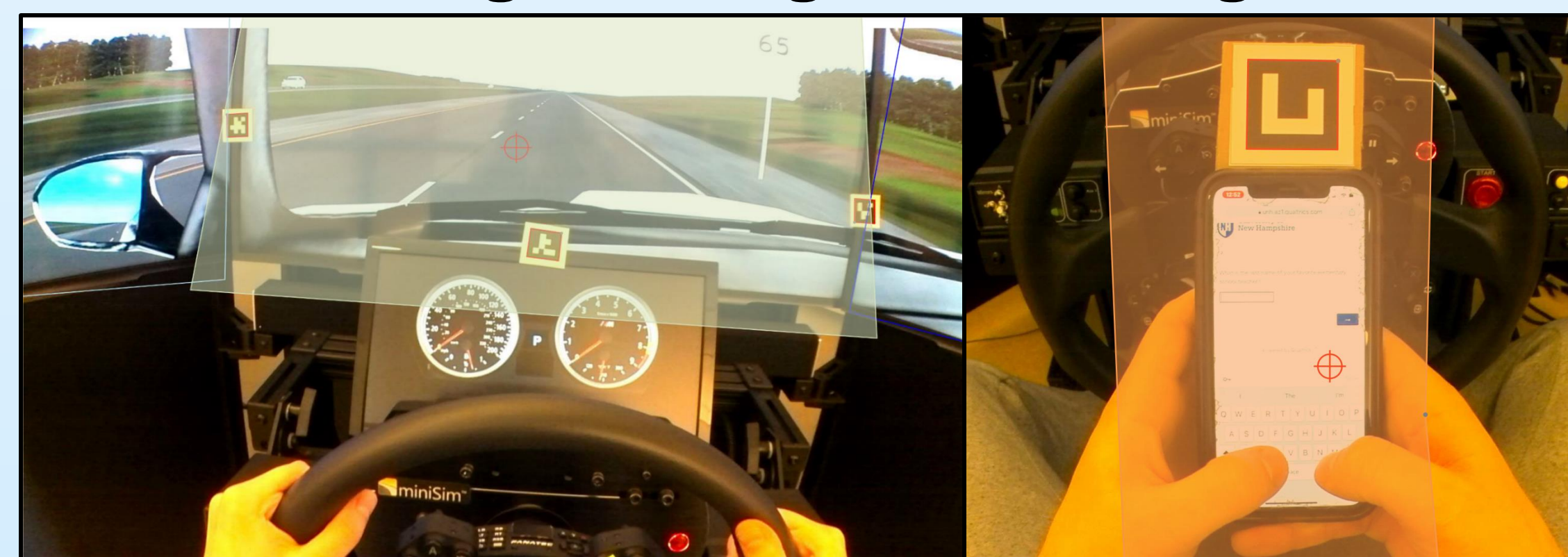


Figure 6: Area of Interest Eye-Tracking

## Results

- Takeover Strategy (Interleaving or Suspension)
- Takeover Performance (Timing and Quality)
- NDRT Engagement (Questions Answered)

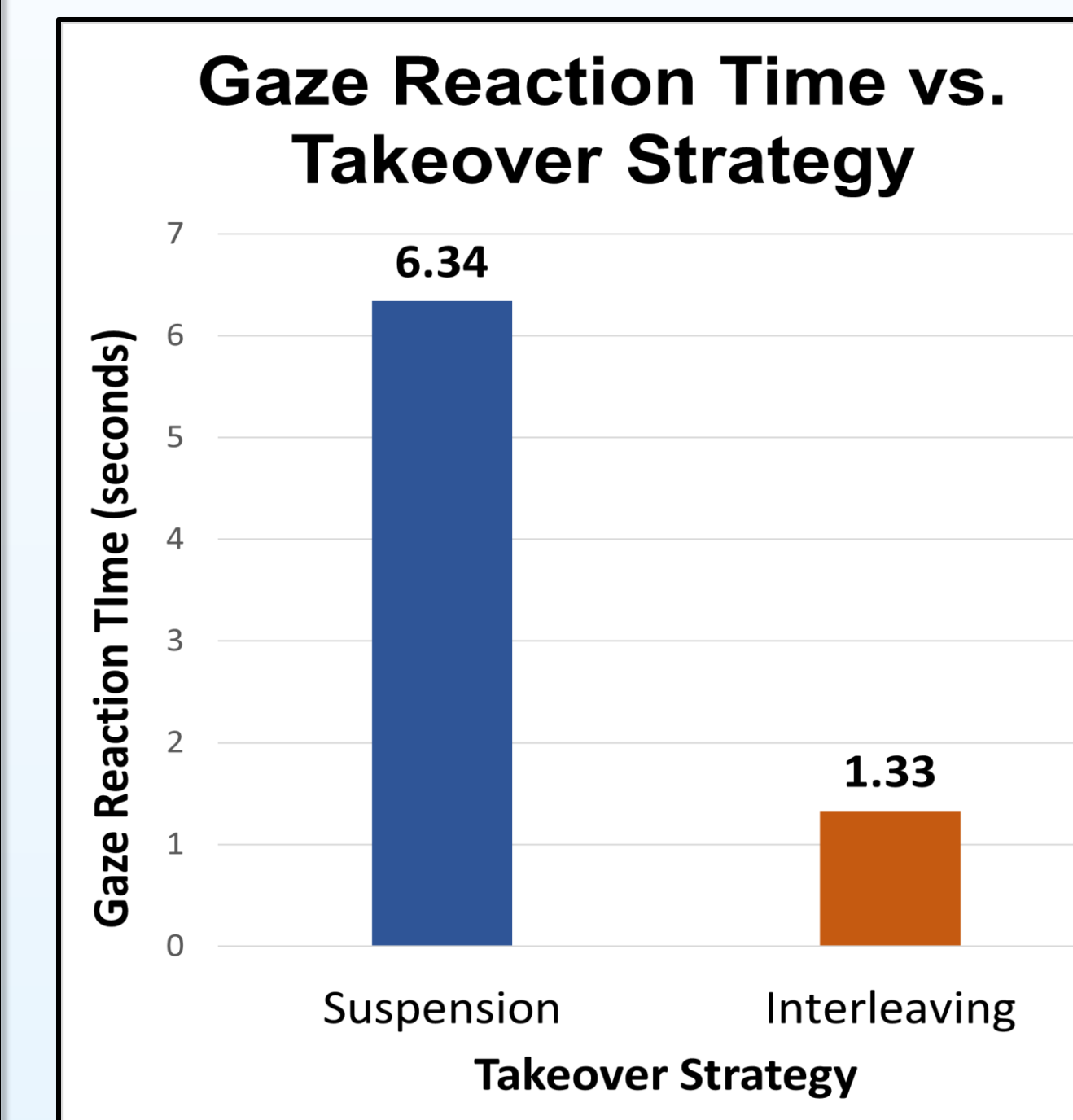


Figure 8: Takeover Timing: Gaze Reaction

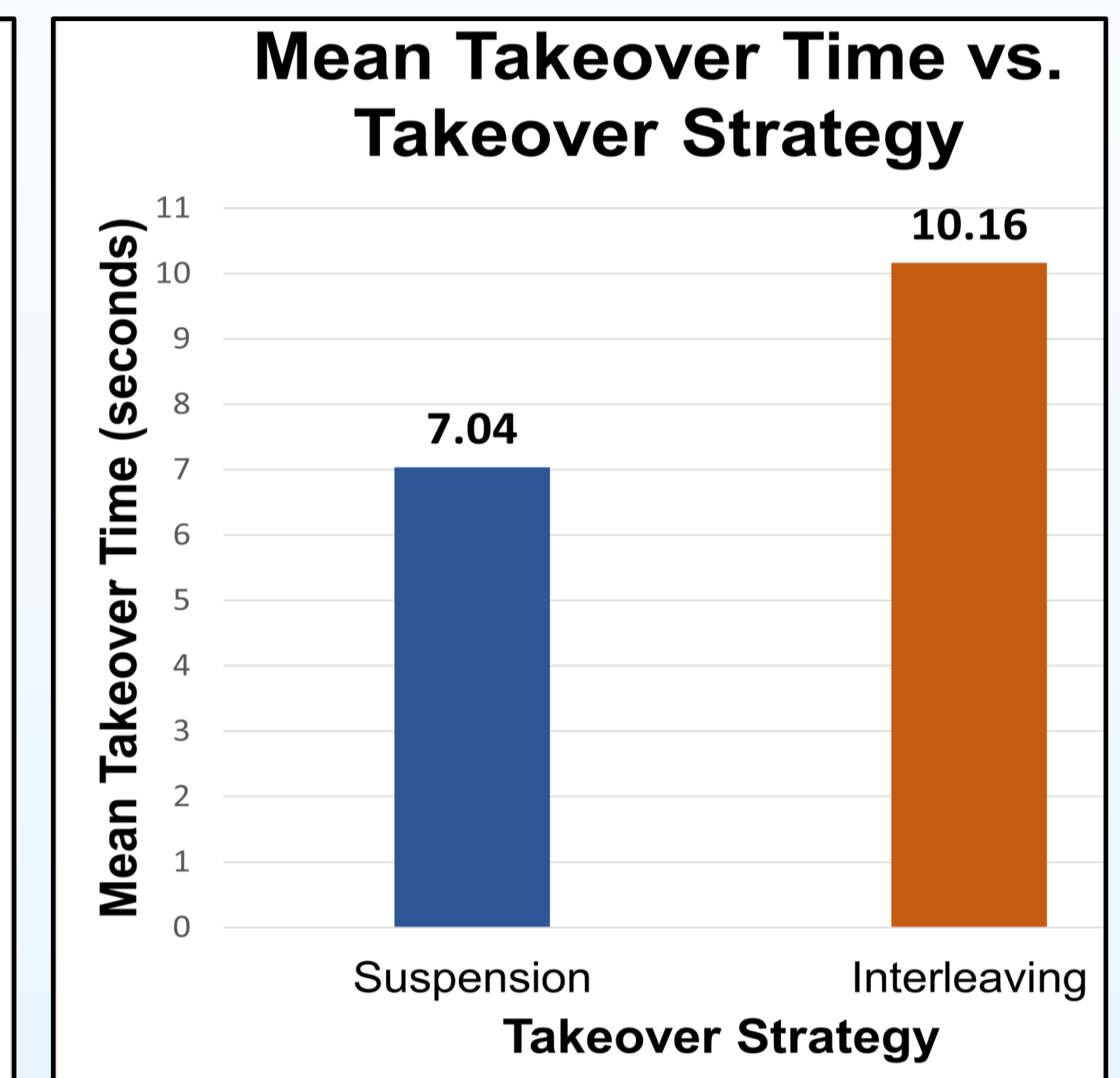


Figure 9: Takeover Timing: Manual Control

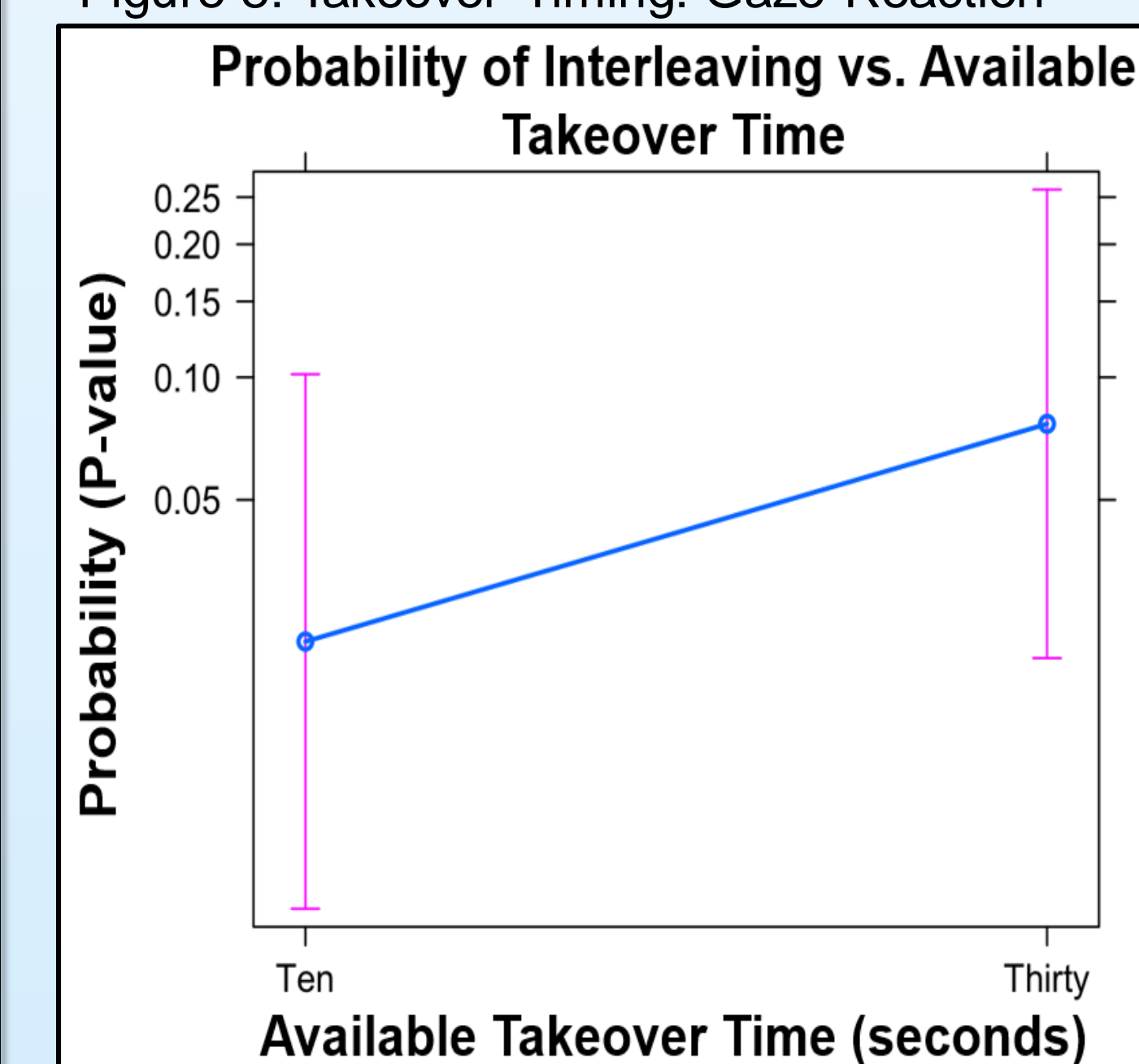


Figure 10: Effect of Interleaving, Takeover Time

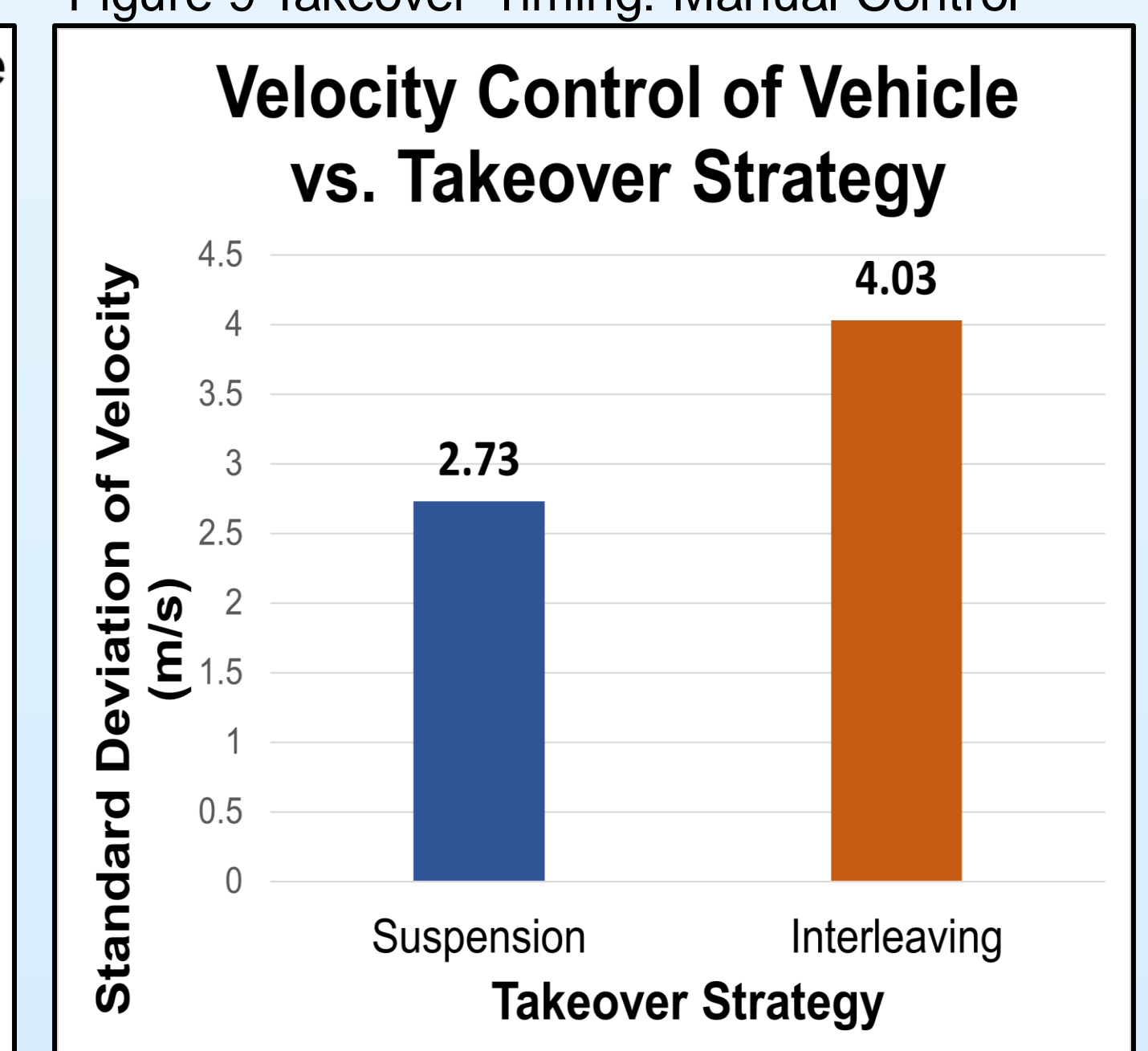


Figure 11: Driver Takeover Performance

## Design

- Participants operated a vehicle using a driving simulator and periodically switched between manual and automated driving.
- During the automated driving phase, participants engaged in three types of texting conversations using a smartphone that required different cognitive demands; *retrieval, generation, assimilation*.
- Participants completed six experiment trials: Text type (3) x Available takeover time (2)

Trial Start	TOR 1		TOR 2		TOR 3		Trial End
Manual Driving 60s	Automated Driving 60s	Manual Driving 60s	Automated Driving 60s	Manual Driving 60s	Automated Driving 60s	Manual Driving 60s	

Figure 2: Sequence of Manual and Automated Segments Within One Trial

## Discussion

- Takeover strategy depends on time available for takeover. (Figure 10)
- Takeover strategy has significant impact on takeover timing. (Figures 8 and 9)
- Vehicle speed control depends on which takeover strategy drivers follow. (Figure 11)
- Takeover strategy does not depend on different types of texting conversations.

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