

# Investigating Variations in Cycling Behavior

Based on Demographics and Self-reported Cycling Style using Bicycle Simulator Data

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## Introduction



Cycling safety is a critical urban challenge. Understanding diverse cyclist behaviors in complex traffic scenarios is essential for designing safer infrastructure

## Research Gap

### Disconnected prior work:

Existing studies often focus on isolated behaviors and psychological factors independently, lacking integrated approaches

## Research Question

RQ1:  
How do CSQ psychological dimensions (Safety, Speed, Focus, Calmness) relate to observable behaviors in a simulator?

RQ2:  
How can trajectory data be effectively translated into behavioral clusters?

RQ3:  
Can behavioral clusters be robustly predicted using psychological and infrastructure factors?

## Participants



27 Males

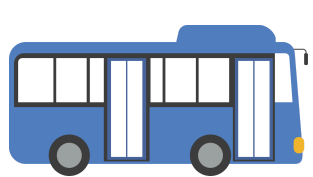
49

Participants



22 Females

## Three Scenarios



Overtaking  
Bus

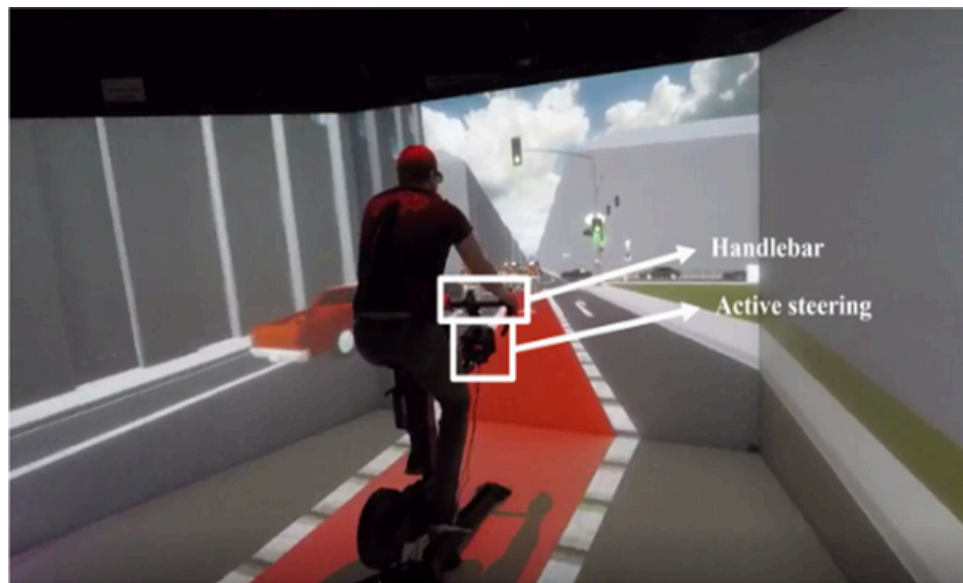


Signalized  
Intersection



Unsignalized  
Intersection

## CAVE Bicycle Simulator



OpenDrive

RoadRunner

SUMO



High  
Immersion



Realistic  
Interface

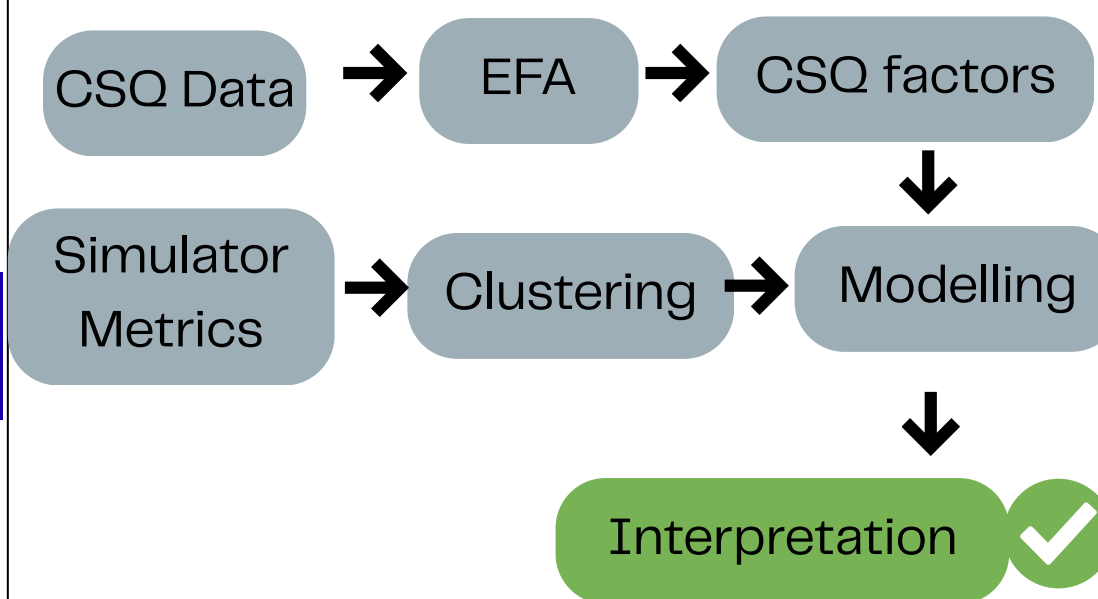


Simulation



Data  
Capture

## Study Flowchart



## CSQ VALIDATION

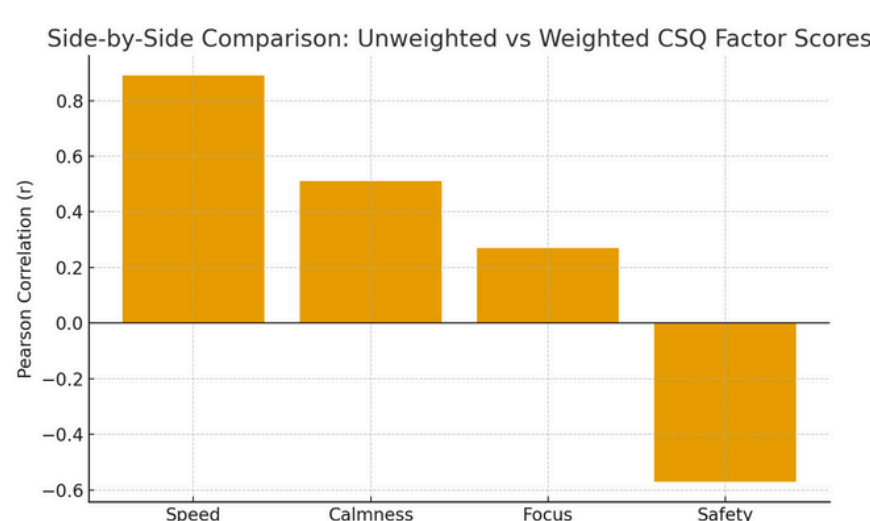
### Exploratory Factor Analysis:

4 factors identified: Safety, Speed, Focus, Calmness

### Cronbach's $\alpha$ (Reliability Check):

Low overall reliability values attributed to small sample size (N=49)

### Factor Score Computation:



The inverse Safety correlation reflected unstable loadings, due to the small size

Unweighted factor scores were selected for the analysis due to superior stability

## Behavioral Clusters



**Cautious Riders:** Strong lane adherence. Riders minimize risk by strictly following implied infrastructure paths



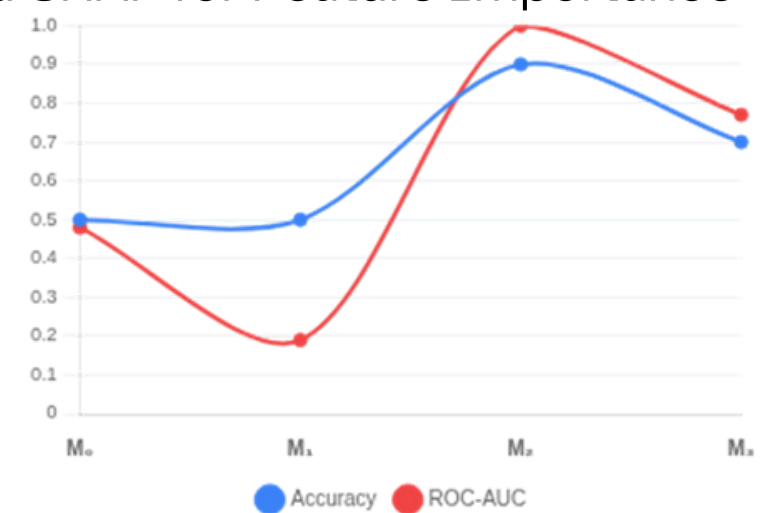
**Adaptive Riders:** Moderate DTW distances and partial infrastructure similarity indicate a flexible path-following approach that balances efficiency with safety.



**Assertive Riders:** Riders with high DTW distances and low infrastructure-type similarity deviate more prominently from the designated reference paths.

## Modelling Behavior

Logistic Regression for Classification and SHAP for Feature Importance



M2 Model

CSQ + Demographics + Behavior

## Conclusion

An integrated approach successfully classifies and clusters cyclist behavior. Speed metrics, Motion quality, Infrastructure type, CSQ factors, and Demographics are strong predictors

## Limitations

Limited participant pool, Low CSQ reliability scores, Simulator constraints, and simplified infrastructure types

## Outlook

Expand participant pool, validate with real-world data, and integrate with autonomous vehicle algorithms.