



10th International Conference on



RSS2026

Road Safety & Simulation

23-26 June 2026, Naples, Italy

Driver Adaptation Patterns in Car-Following: A Preliminary Safety-II Analysis

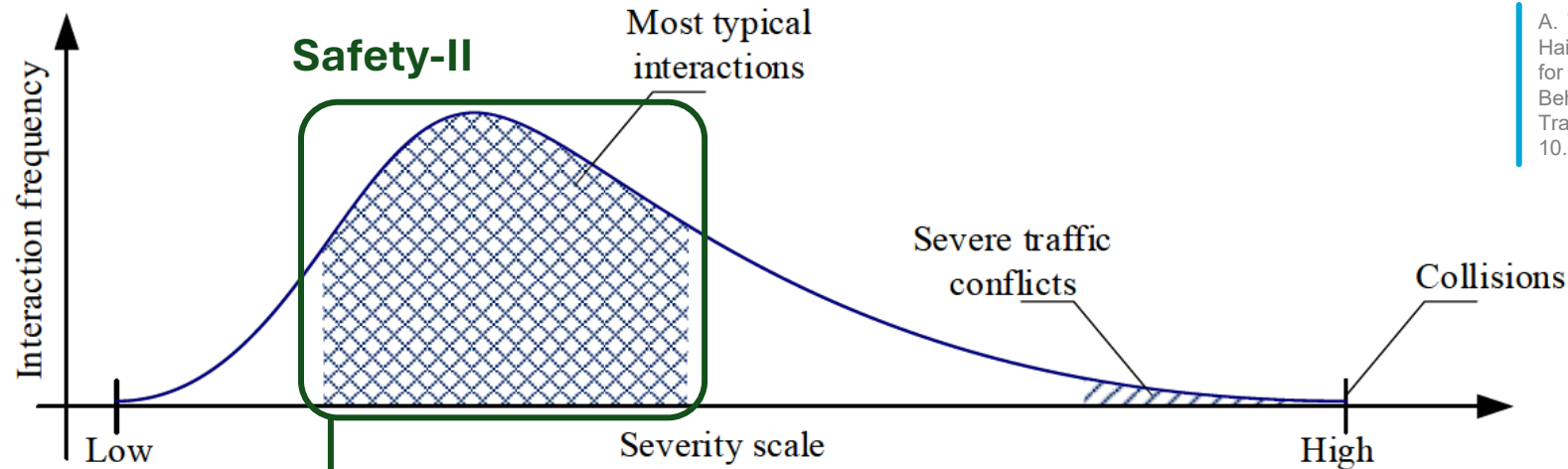
Paper ID: 178

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- Driving is a dynamic control task under uncertainty

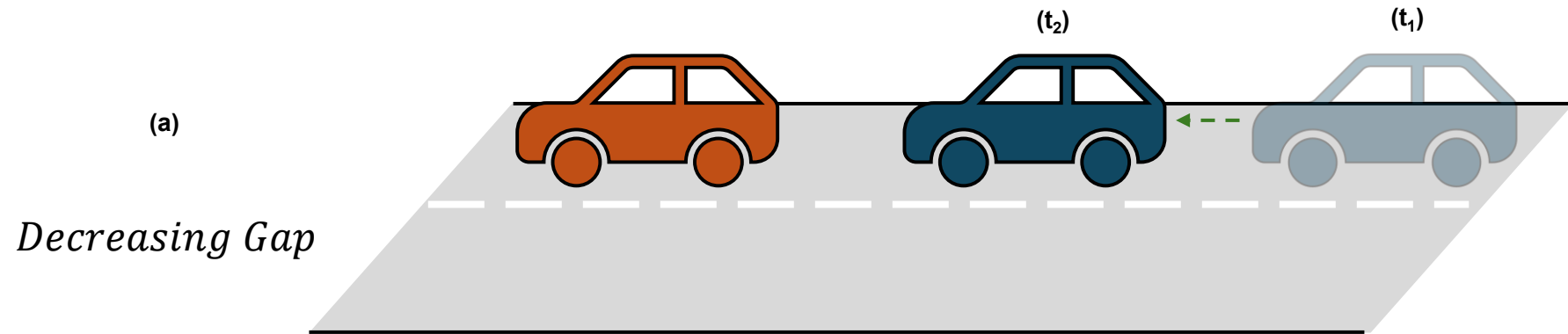


A. Tejada, J. Manders, R. Snijders, J.-P. Paardekooper, and S. de Hair-Buijssen, "Towards a Characterization of Safe Driving Behavior for Automated Vehicles Based on Models of 'Typical' Human Driving Behavior," in 2020 IEEE 23rd International Conference on Intelligent Transportation Systems (ITSC), Sep. 2020, pp. 1–6. doi: 10.1109/ITSC45102.2020.9294184.

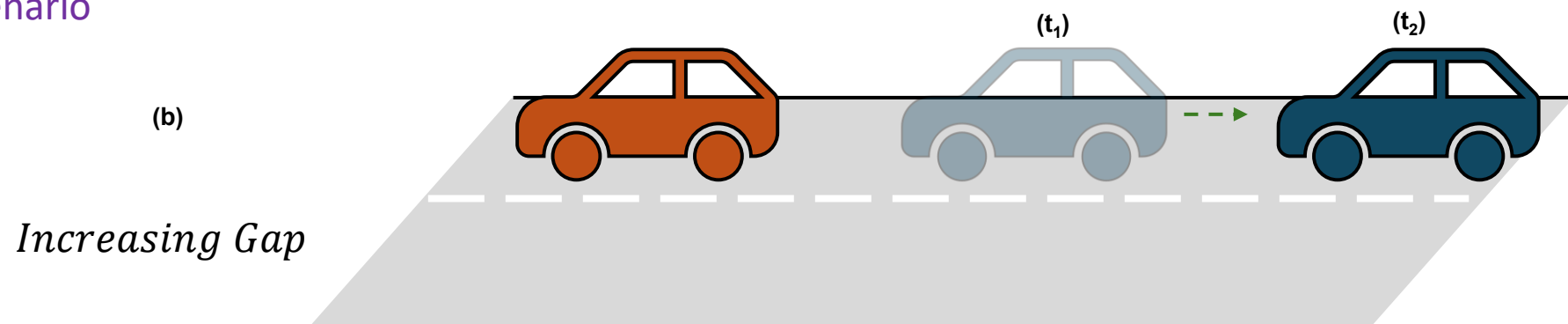
- Successful Interactions
- Instead of asking why drivers fail, we ask how they usually succeed

How do drivers stay safe during these trips?

- **Behavioural Adaptation:** Moments where drivers adapt their behaviour in response to surrounding traffic dynamics.

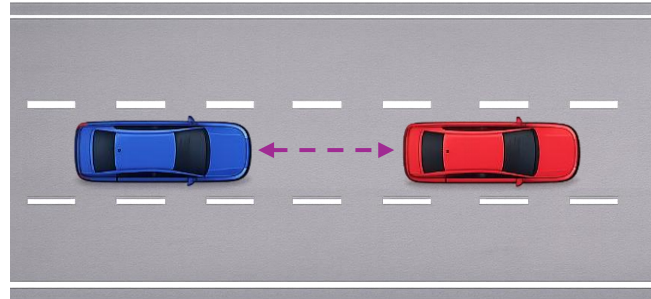


➤ Car-following Scenario

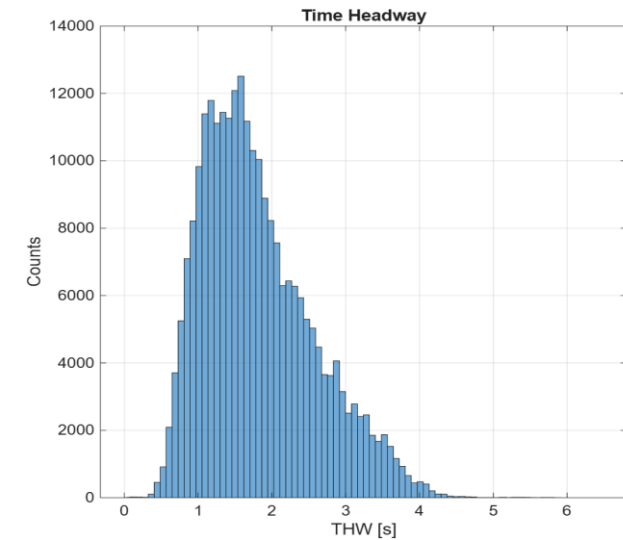
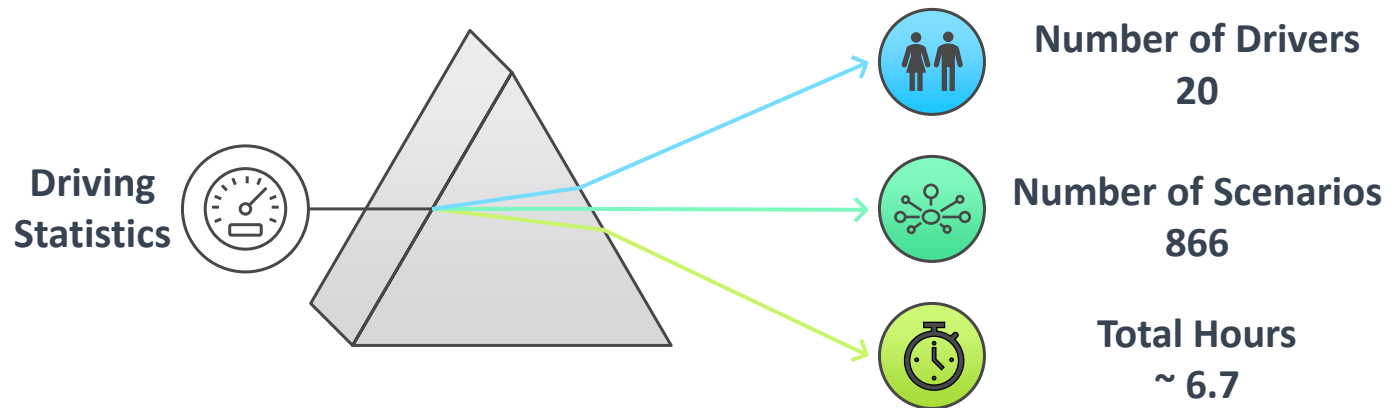


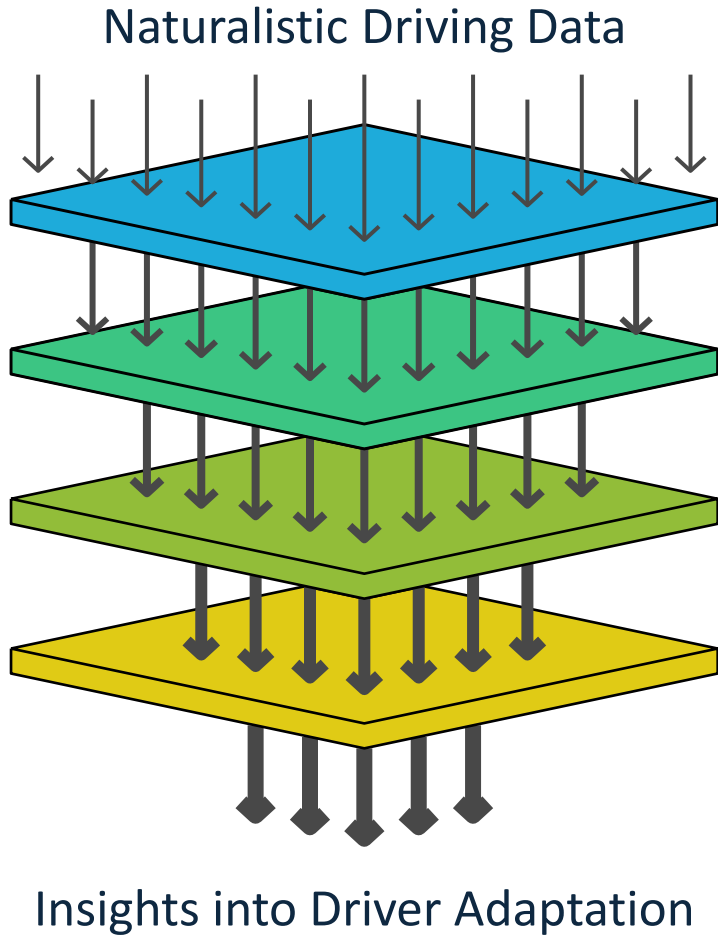


➤ Car-following Scenarios



- Same Lane (Highway)
- Longitudinal Distance < 200m
- Ego's Velocity > 60km/h

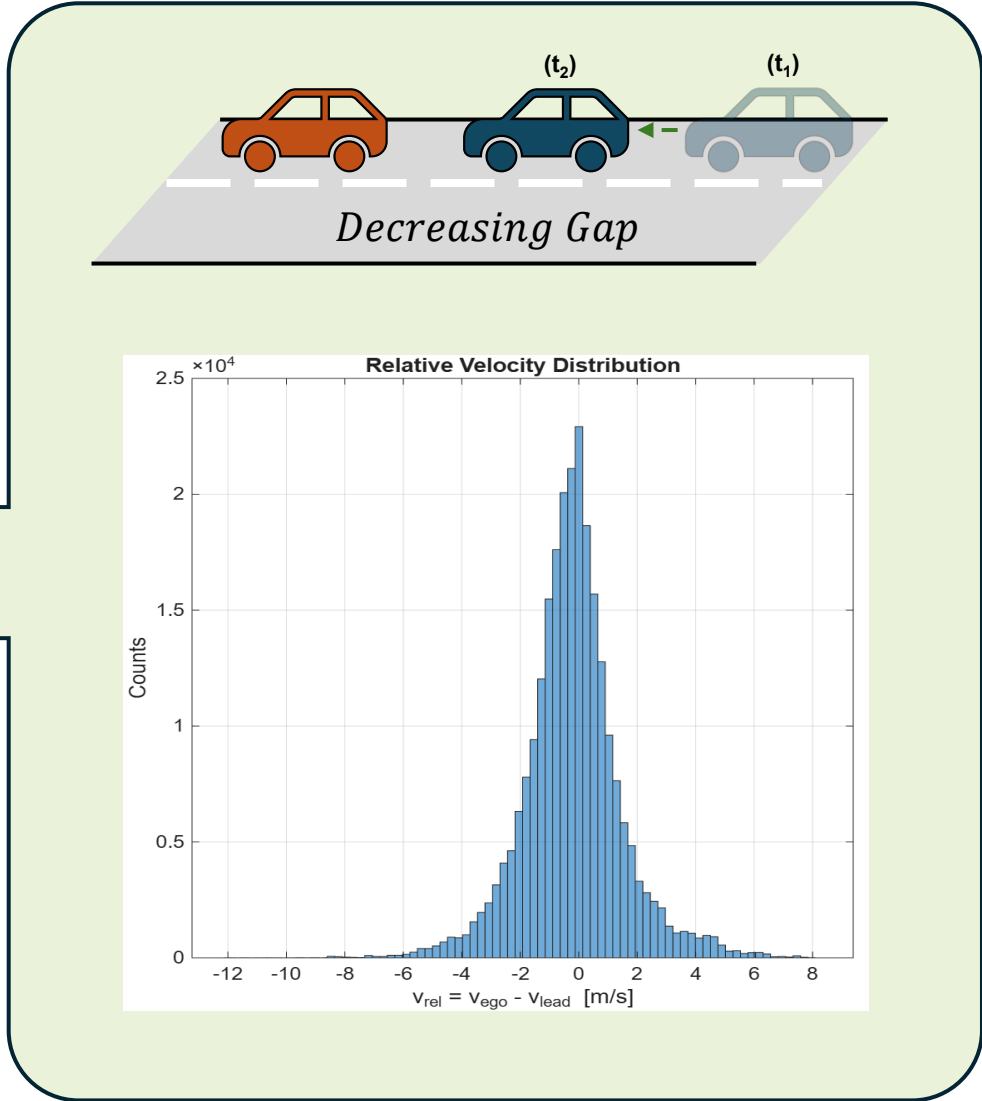




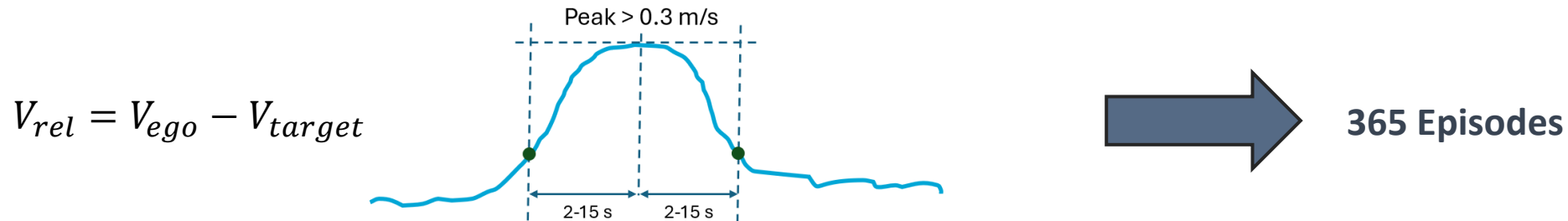
Cleaning

Car-following Scenarios

Adaptation Moments

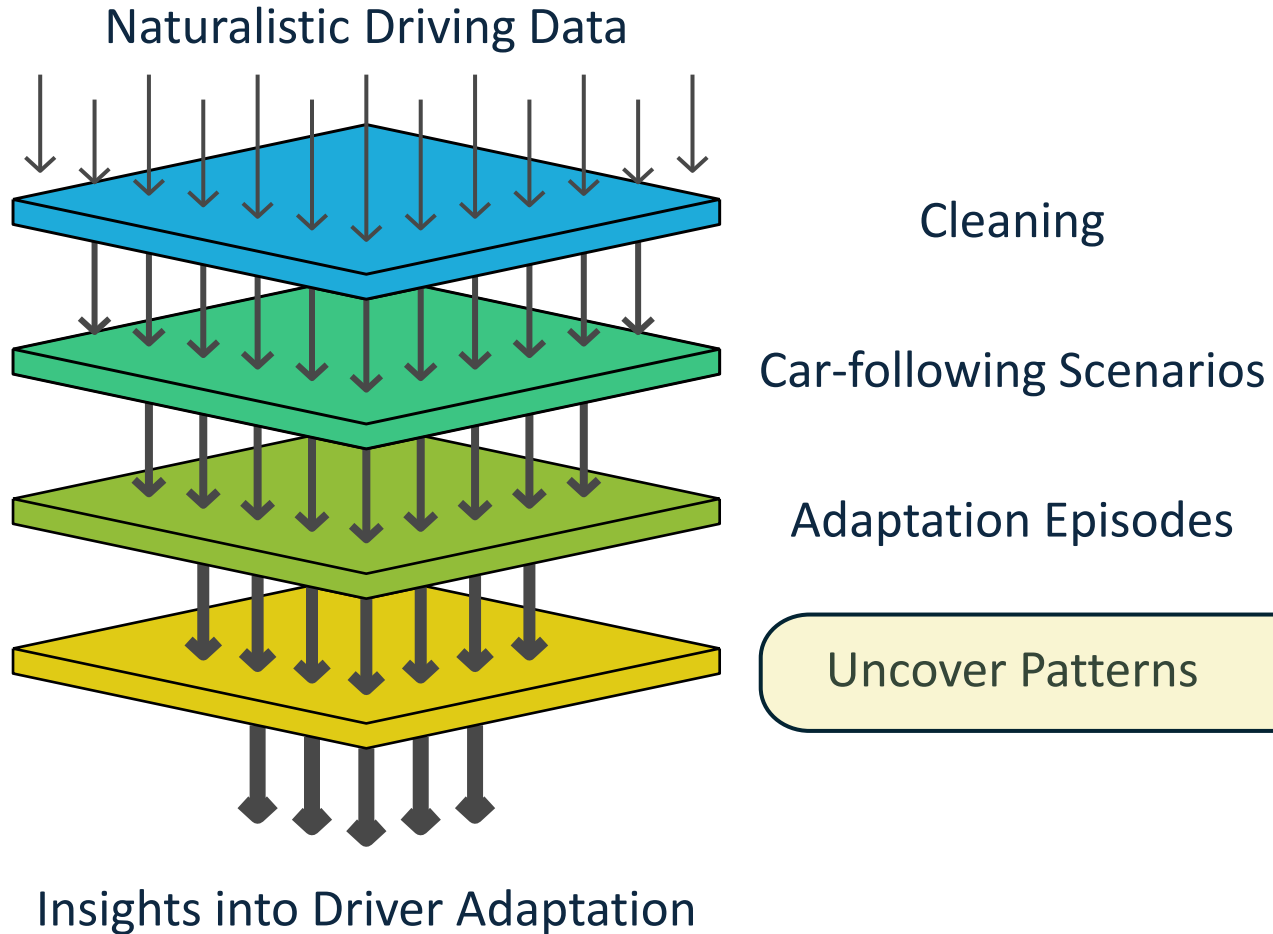


- **Adaptation Episode:** A structured rise followed by recovery in relative velocity during car-following.



Parameter	Value	Justification
V_{rel} peak value	>0.3 m/s	Filter noise (Mortimer et al., 2014)
Rise/recovery threshold	50% difference	Symmetric definition (+ Result from sensitivity analysis)
Minimum rise/recovery duration	2 seconds	Exclude short oscillations and non-adaptive responses
Maximum rise/recovery duration	15 seconds	Exclude slow drifts (Kesting and Treiber, 2008)

Mortimer, R., Hoffmann, E., Kiefer, A., 2014. The Psychological and Accident Reconstruction “Thresholds” of Drivers’ Detection of Relative Velocity. Presented at the SAE 2014 World Congress & Exhibition, SAE International. <https://doi.org/10.4271/2014-01-0437>
 Kesting, A., Treiber, M., 2008. How Reaction Time, Update Time, and Adaptation Time Influence the Stability of Traffic Flow. Computer-Aided Civil and Infrastructure Engineering 23, 125–137. <https://doi.org/10.1111/j.1467-8667.2007.00529.x>

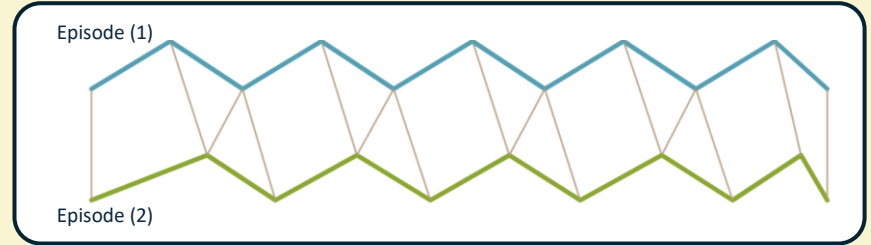


Time-Series Clustering Approach

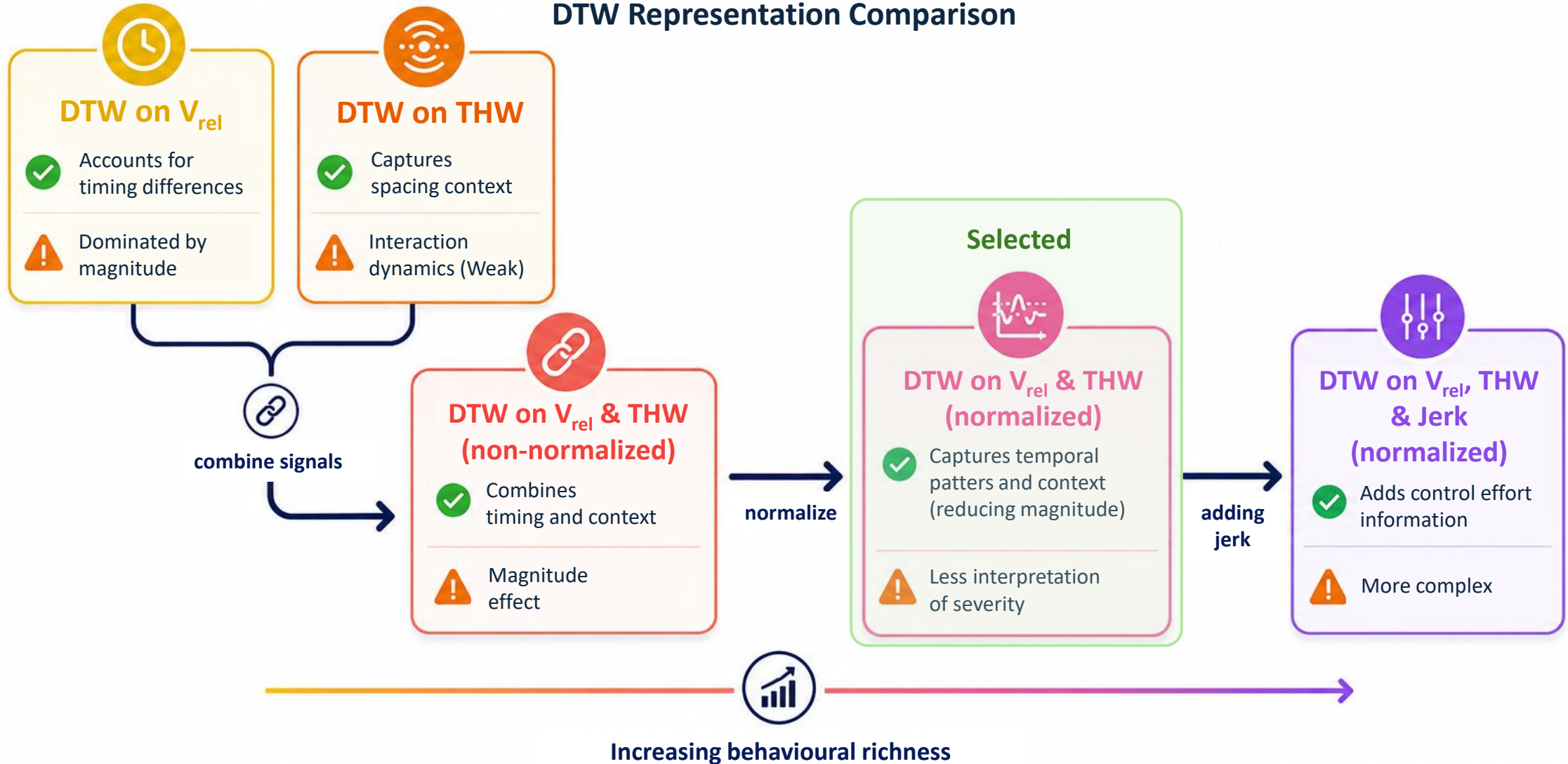
- Identifying temporal patterns

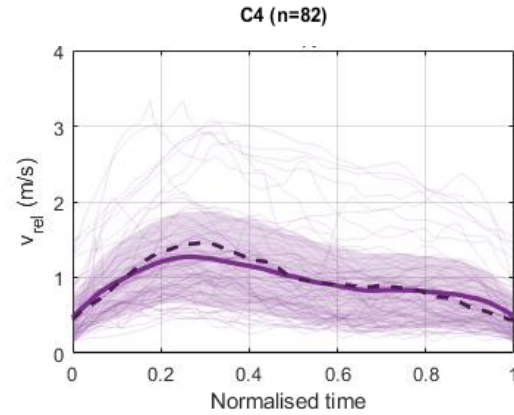
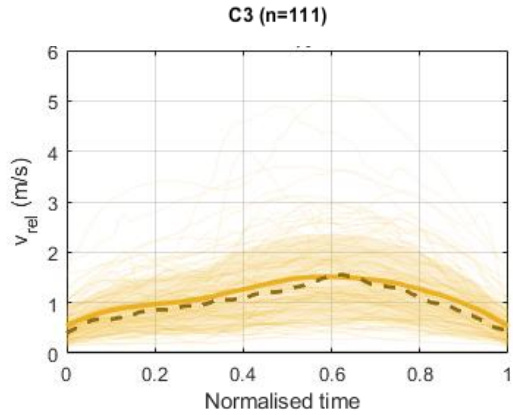
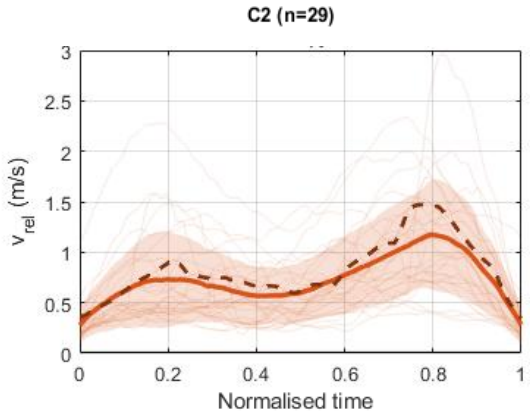
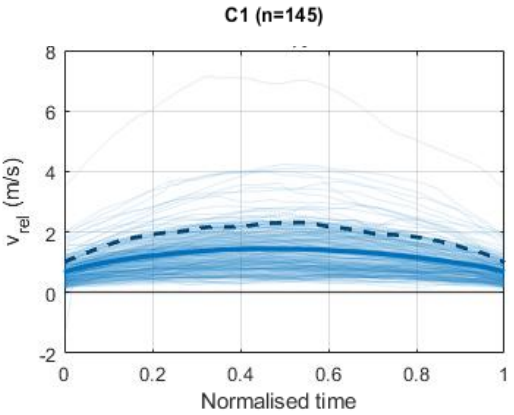
Dynamic Time Warping (DTW)

- Similar shapes, different timing



DTW Representation Comparison



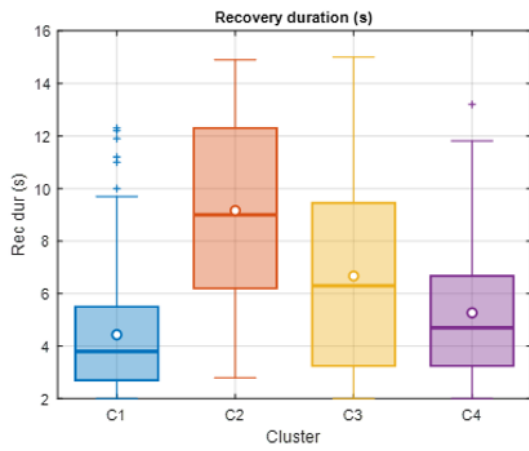
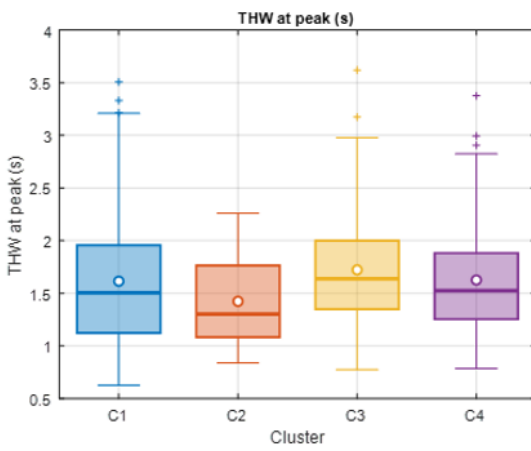
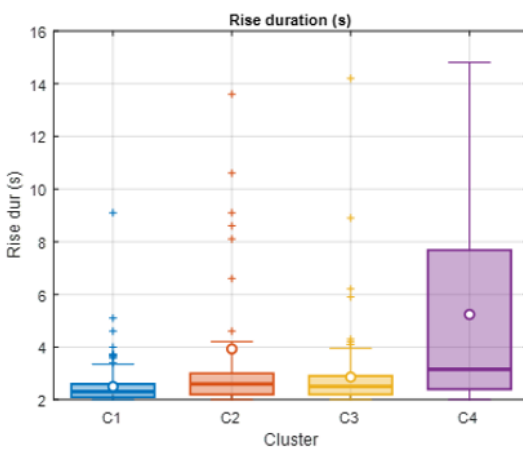
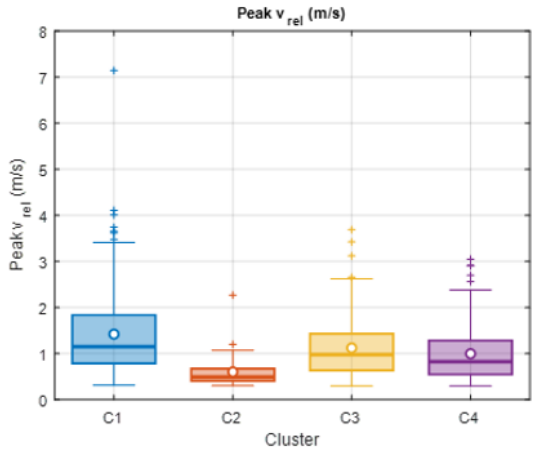
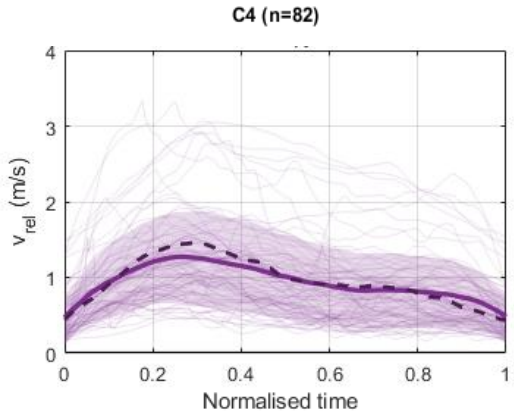
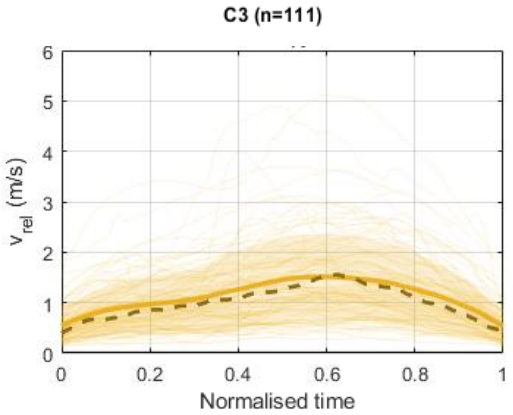
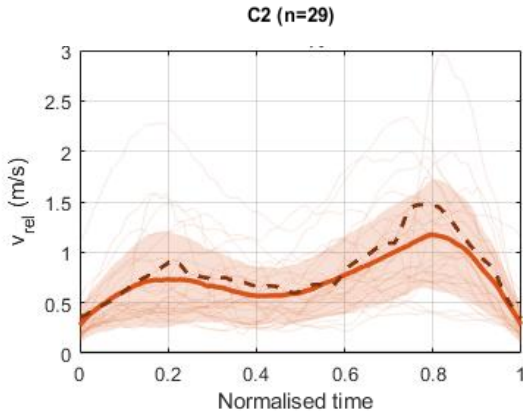
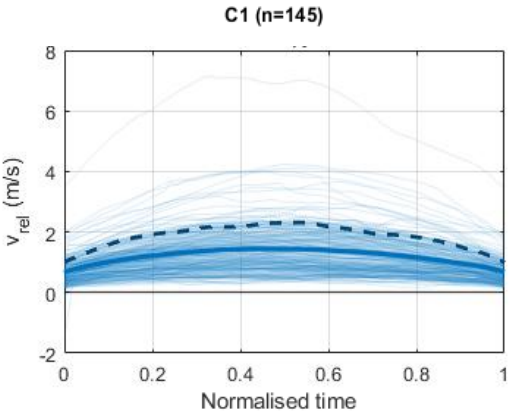


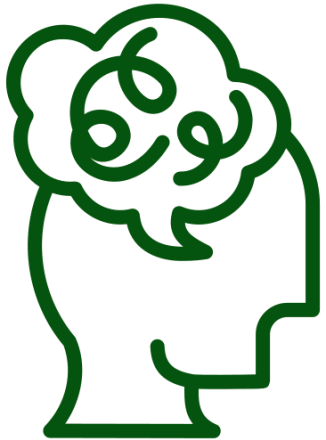
Symmetric Regulation

Delayed Adaptation

Moderate Adaptation

Slow Buildup





- **Safety-II as a Complement to Safety-I**
- **Four distinct temporal adaptation patterns**
 - **Variation in timing rather than intensity**
- **Considering more drivers (Other Datasets)**
- **Adding contextual effect (e.g. Traffic intensity)**
- **Driver-level behaviour**
- **Definition of adaptation**



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Thank You for Your Attention



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