



The effectiveness of an intelligent speed assistance system with real-time speeding interventions for truck drivers: a Belgian simulator study

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Introduction speeding and truck traffic safety

By estimation 10%-15% of all crashes and 30% of all fatal accidents are a direct result of inappropriate speed. [1]

Speed increases both the chance of having and accident and the severity of the accident

Because of their large size and weight, accidents involving trucks are often more severe, especially for the opposing vehicle

Speed limits for trucks:

- Are often different from speed limits for cars
- Are frequently determined by road context instead of traffic signs

[1] European Commission, Road Safety thematic report – Speeding, European Road Safety Observatory, Brussels, European Comission, Directorate General for transport, 2021.



ADAS system that aims to reduce speeding behavior by providing information about the enforced speed limit

Can be combined with real-time interventions for nudging or warning drivers

Can be camera-based (reading speed signs), based on geolocation (speed-map) or a combination of both.

EU mandates ISA-systems in new vehicles (including trucks) from 2022 onwards

In this study: Speeding = exceeding the enforced speed limit for trucks

Visual + Auditory warnings

No active interventions (braking, reducing power)

Camera-based speed limit detection, adjusted for trucks

- 60 km/h for trucks 70 km/h sign -> 90 km/h sign 90 km/h for trucks -> ۲
- 90 km/h for trucks Motorway sign ->



i-DREAMS project Overview





i-DREAMS project simulator experiments

Driving simulation to validate technology and real-time interventions

Trials in 5 different countries, for different modes (car, truck, bus, rail)

In Belgium:

- Truck
- 30 participants
- Focus on speeding and tailgating





Driving Simulator

DriveSimSolutions TruckSim simulator

Realistic seating position, authentic driving controls.

Customized for i-DREAMS technology: **Hardware-in-the-loop**:

- i-DREAMS intervention device (display), Mobileye, Cardiowheel, i-DREAMS gateway
 Software-in-the-loop:
- i-DREAMS real-time intervention algorithms

STISIM Drive 3 simulation software with heavy vehicle physics.

Speed limiter was not activated – max achievable speed was +-100 km/h.







Real-time interventions

Enforced speed limit for trucks is displayed

Visual and auditory interventions, based on threshold exceeding.

Intervention stage	Visual Warning	Description visual warning	Auditory warning	
Normal driving – Speed limit detected	50	Statically displayed as large icon for 1s, then continuously displayed as a small icon	None	
	50)			
Dangerous driving – exceeding threshold 1	50	Statically displayed as large icon for 1s, then continuously displayed as a small icon	None	
	50 +			
Avoidable accident – exceeding threshold 2	50	Flashing as large icon for 1s, then continuously displayed as a small icon	Auditory chime	() € 130
	80 *			0.0



Experiment design

Research objective:

- Do real-time speeding interventions influence driving behavior with regards to speeding for truck drivers?
- Can the effectiveness of speeding interventions for truck drivers be correlated to the type of road?

Within subject design - 34 participants, all truck drivers (32) or truck driver coaches (2)

3 drives

- Baseline (no interventions)
- Intervention (normal interventions)
- Fatigue (interventions + simulated sleepiness)

Scenario:

- 15km
- 3 different road types, in a Flemish (Belgian) context
- The order of road types was different and randomized for the 3 drives

Road Section	Speed Sign	Speed limit for trucks $(>3,5T)$
Rural road with 2 lanes (1x1)	70 km/h	60 km/h
Rural road with 4 lanes $(2x2)$, divided by median section	90 km/h	90 km/h
Motorway with 6 lanes $(3x3)$, divided by median section	Motorway Sign	90 km/h



Data Analysis

sections of interest (700m) for each road type without events or leading vehicle





Data Analysis

RMANOVA to investigate the effect of interventions on speed related variables

Road Section	Parameter	dfs	F	р
	Average speed	2,64	13.682	<0.001
	Minimum speed	1.777, 56.867	15.716	<0.001
Rural – 60km/h - 1	Maximum speed	2,64	5.081	0.009
	percentage of distance 5% above limit	2,64	13.405	<0.001
	Percentage of distance below limit	1.416, 45.326	1	0.351
	Average speed	2,64	6.674	0.002
Rural – 60km/h - 2	Minimum speed	2,64	5.282	0.008
Rural – 60km/h - 2	Maximum speed	2,64	5.664	0.005
	percentage of distance 5% above limit	1.522, 48.715	14.487	<0.001
	Percentage of distance below limit	1.381, 44.187	0.298	0.661
Rural – 90 km/h	Average speed	2,64	0.496	0.611
	Minimum speed	2,64	0.940	0.396
	Maximum speed	2,64	0.352	0.705
	percentage of distance 5% above limit	1.119, 64	0.027	0.893
	Percentage of distance below limit	2,64	1.307	0.278
	Average speed	2,64	2.325	0.106
Motorway – 90 km/h	Minimum speed	2,64	5.969	0.004
	Maximum speed	1.742, 55.736	0.614	0.523
	percentage of distance 5% above limit	2,64	0.554	0.577
	Percentage of distance below limit	1.665, 53.279	2.120	0.138
	Average speed	2,64	6.058	0.004
Across all sections	percentage of distance 5% above limit	1.645, 52.630	19.085	<0.001
	Percentage of distance below limit	2,64	1.278	0.286



Data Analysis

Descriptive statistics of speeding variables

60 km/h = 16.66 m/s 70 km/h = 19.44 m/s 90km/h = 25 m/s

Road section	Drive	Average speed (m/s)		Minimum speed (m/s)		Maximum speed (m/s)		Percentage of distance 5% above speed limit (%)		Percentage of distance below speed limit	
		mean	S.D.	mean	S.D.	mean	S.D.	mean	S.D.	mean	S.D.
Rural – 60	1.Baseline	18.08 _{1,2}	0.23	17.051,2	0.27	18.93 ₁	0.26	63.04 _{1,2}	6.91	1.37	0.79
km/h - 1	2.Intervention	16.99 ₁	0.16	15.851	0.20	18.08 ₁	0.18	30.891	5.54	3.34	1.94
	3.Intervention + sleepiness	17.26 ₂	0.20	16.09 ₂	0.16	18.28	0.26	36.56 ₂	6.07	1.23	0.71
Rural – 60	1.Baseline	17.80 _{1,2}	0.30	16.88 _{1,2}	0.31	18.671,2	0.29	52.37 _{1,2}	7.69	5.19	3.50
km/h - 2	2.Intervention	17.09 ₁	0.26	16.18 ₁	0.24	17.91 ₁	0.29	22.24_{1}	5.96	2.75	1.41
	3.Intervention + sleepiness	16.95 ₂	0.20	16.17 ₂	0.23	17.75 ₂	0.20	25.73 ₂	6.23	4.61	2.09
Rural – 90	1.Baseline	23.01	0.45	21.88	0.45	24.22	0.51	3.82	1.51	28.78	7.53
km/h	2.Intervention	22.53	0.42	21.11	0.42	23.97	0.47	3.21	2.27	43.93	7.07
	3.Intervention + sleepiness	22.63	0.42	21.64	0.44	23.77	0.44	3.66	3.07	38.08	7.46
Motorway –	1.Baseline	24.34	0.17	22.59 ₂	0.30	25.39	0.19	8.10	3.80	6.91	2.29
90 km/h	2.Intervention	24.12	0.25	22.24 ₃	0.36	25.26	0.29	7.07	2.47	10.26	3.48
	3.Intervention + sleepiness	24.64	0.14	23.53 _{2,3}	0.23	25.57	0.16	4.18	2.12	3.34	1.49
All sections	1.Baseline	20.811	0.21					31.82 _{1,2}	3.61	10.56	2.78
combined	2.Intervention	20.18 ₁	0.20					15.851	2.88	15.01	2.24
	3.Intervention + sleepiness	20.37	0.15					17.53 ₂	2.99	11.83	2.11
					0						

Note: means sharing subscript are significant at the 5% confidence level after Bonferroni correction.



Conclusion and further work

Significant reduction for almost all speeding related variables on road types with a speed limit of 60km/h Not on road types with speed limit of 90 km/h.

- The i-DREAMS ISA system is effective at reducing speed at typical rural roads with a speed limit of 60km/h for truck drivers.
- Only on the road sections with a speed limit of 60 km/h, does the enforced speed limit (60 km/h) differ from the speed limit signs on the road (70 km/h)
 - This suggests that ISA systems are most effective of roads where the speed limit is inferred from context rather than speed limit signs
- ISA systems might be more effective to reduce speed on road sections with a lower speed limit
 - Results show very little speeding on roads with a speed limit of 90km/h, even though there was no speed limiter.
- More research is needed to compare:
 - different road types with low speed limit
 - Roads with inferred speed limit vs roads with the enforced speed limit displayed on traffic signs





Call for papers

Special issue of Sustainabillity: "Application of Advanced Simulators for Enhancing the Mobility and Safety Levels of the Transportation System"

Deadline: 1 March 2023

Link: More Information