

Quantifying the effect of street design on driving speed on urban roads

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INTRODUCTION

LOWER SPEED LIMITS ON URBAN ROADS

Reducing speed on urban roads improves quality of life (safety, noise emissions) (Häfliger et al., 2019, Aarts & van Schagen, 2006)

Low compliance with lower speed limits (Niemann, 2020):

- CH: 64% comply to 50km/h speed limit;
- CH: 46% comply to 30 km/h speed limit

The image shows the cover of a brochure from the Schweizerische Vereinigung der Verkehrsingenieure und Verkehrsexperten (SVI). The title is 'Merkblatt 2021/01 Tempo 30 auf Hauptverkehrsstrassen'. The text on the cover discusses the implementation of 30 km/h speed limits on main roads in urban areas, mentioning that it is a topic of debate in society and politics, and that the brochure provides information for planning and public administration.

Hool, A., U. Huwer and R. Häfliger (2021) Tempo 30 auf Hauptverkehrsstrassen, 2021/01, Merkblatt, SVI Schweizerische Vereinigung der Verkehrsingenieure und Verkehrsexperten, Zürich.



Für die eilige Leserin, den eiligen Leser
Im Fokus dieses Merkblatts steht die Umsetzung von Tempo 30 auf Hauptverkehrsstrassen (HVS). Die gleichen Fragen betreffen aber auch andere übergeordnete Strassen wie Verbindungsstrassen (VS) oder Hauptsammelstrassen (HSS). Ist im Merkblatt von HVS die Rede, sind sinngemäss auch die anderen Strassentypen mitgemeint. Die ausgewerteten Fallbeispiele sind mit wenigen Ausnahmen Strassen mit einem durchschnittlichen täglichen Verkehr (DTV) von über 5000 Fahrzeugen.

Impressum
Herausgeber:
SVI Schweizerische Vereinigung der Verkehrsingenieure und Verkehrsexperten
www.svi.ch
Verfasser des Merkblatts:
Anna Hool, Metron Verkehrsplanung AG
Ulrike Huwer, Basler & Hofmann AG
Ruedi Häfliger, ZHAW

The screenshot shows a news article from the Basler Zeitung (bz) website. The headline is 'Parlament will flächendeckend Tempo 30 im Basler Siedlungsgebiet einführen'. The article discusses the decision of the Grosser Rat (Grand Council) to implement a 30 km/h speed limit throughout the residential area of Basel. It mentions that the decision was made after discussions with various organizations and that the implementation will be gradual.



Die Einführung von Tempo 30 wie hier in der Aeschenvorstadt sorgte für Diskussionen. Kenneth Nars

Signalized speed limits are
an important measure, but
rules and regulations are
not sufficient
(Sadia et al., 2018)

Self-explaining roads
(Theeuwes & Godthelp, 1995, Theeuwes, 2021)

Of central importance:
Road design and
expectations thereof by
drivers

INTRODUCTION

SELF-EXPLAINING ROADS: TWO EXAMPLES



Shared space: Furniture, Alternated parking, no sidewalks



Motorway: Two-lanes, shoulder, viewing angle, no opposing traffic, no pedestrians

INTRODUCTION

SELF-EXPLAINING ROADS?



Urban road: parking, wide median,
surrounding land-use

What is the influence of road design on driving speed on main urban roads?

Different processes interact with road design and influence speed choice:

Cognitive load (mental effort to perform a task)

- Driving situation becomes more complex → Cognitive load increases → Driver reduces speed

Risk perception: Risk tolerance influences driving speed.

- Perceived risk increases → Driver reduces speed to maintain level of risk tolerance

Driving style and performance

Objects in peripheral vision influence perception of speed:

- Proximity increases → Driver reduce speed

Introduction

Methods

Results

Conclusion

METHODS

EXPERIMENT

Step 1
Briefing

Step 2
Training

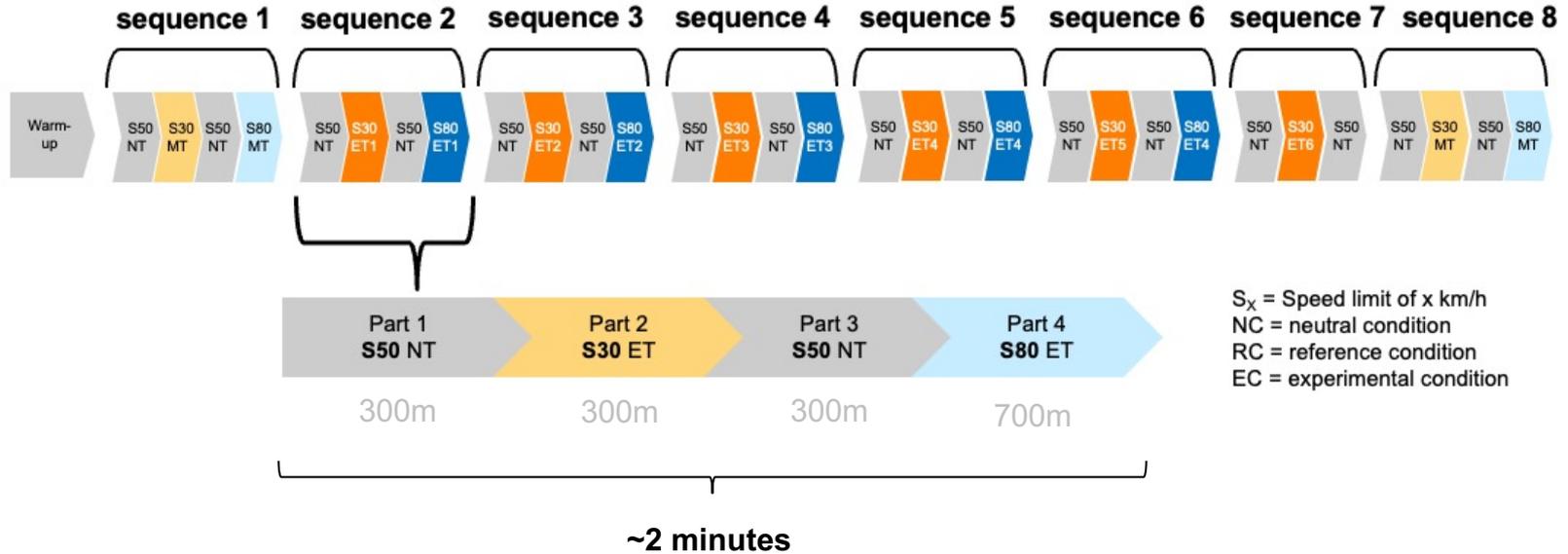
Step 3
VR
Experiment

Step 4
Survey

Step 5
Debriefing



METHODS SEQUENCE



METHODS

TREATMENTS: SELECTION



Minimal condition



On-street parking



Side-markings



Greenery

METHODS

DRIVING SIMULATOR



METHODS

PROCEDURES & MEASUREMENTS

Recruitment

- With market research company and social media, during pandemic
- 54 participants (gender balanced, 50% > 36 years old), after cleaning (motion sickness)

Virtual reality

- Measurement of position every 0.25 seconds

Questionnaire

- **Desired** speed and **safe** speed along each treatment
- **Complexity** and **safety perception** of each treatment (Wang et al. 2019)
- Driving style (French et al. 1993, Chowdhury, 2014):
 - 16 items, aims to extract sensation-seeking, focusing while driving, and more
- Driving performance (Victoir et al. 2005) :
 - Six items, aims to extract rule-obedience
- Driving experience in VR, presence / immersion in VR (Kronqvist et al., 2016, Witmer & Singer, 1998)
- Simulator Sickness Questionnaire SSQ (Kennedy et al., 1993).



Introduction

Methods

Results

Conclusion

RESULTS

DRIVING SPEED IN VR: TREATMENT EFFECTS



	Short-term effect with driving style and practice	Long-term effect with driving style and practice
Intercept	33.701 (<0.001)***	33.439 (<0.001)***
T1: Side-marking	-1.073 (0.117)	-0.434 (0.477)
T2: Bicycle-lane	-0.133 (0.845)	-0.187 (0.759)
T3: Wide centrelane marking	1.046 (0.126)	0.858 (0.161)
T4: Parking lots	-0.501 (0.463)	-0.241 (0.693)
T5: No centreline	-1.304 (0.057)+	0.020 (0.974)
T6: Trees	-1.517 (0.027)*	-1.262 (0.039)*
Sensation seeking	1.571 (0.024)*	1.150 (0.087)+
Rule obedient	-1.290 (0.082)+	-1.281 (0.057)+
N	378	378
N (subjects)	54	54
R2 (conditional)	0.35	0.33
R2 (marginal)	0.09	0.07
AIC	2110.890	2024.955

Average speed measured for:

- 50 – 100m into the section
- 100m – 225m into the section

Average speed in both segments

- ~ 33.5 km/h

Short-term and long-term effects

- Greenery (T6), reduction of -1.5 km/h

Short-term only

- No centre line (p=0.057)
- Wide centre lane marking (p=0.126)
- Side-marking (p=0.117)

RESULTS

DRIVING SPEED IN VR: DRIVING STYLE AND PRACTICE



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Driving style

- Sensation-seeking results in a higher driving speed

Driving practice

- Rule obedience results in a lower driving speed

RESULTS

SAFE & DESIRED SPEED

	Safe speed	Safe speed, incl. complexity & safety
Intercept	41.278 (<0.001)***	42.252 (<0.001)***
T1: Side-marking	1.907 (0.207)	6.747 (0.015)*
T2: Bicycle-lane	6.926 (<0.001)***	14.309 (<0.001)***
T3: Wide median	-1.500 (0.320)	2.172 (0.432)
T4: On-street parking	-8.093 (<0.001)***	3.302 (0.417)
T5: No centre line	-0.685 (0.650)	11.092 (<0.001)***
T6: Greenery	1.944 (0.198)	12.594 (<0.001)***
Sensation seeking	0.444 (0.791)	
Complexity		-0.429 (0.468)
T1: Side-marking (safe -> unsafe)		-2.444 (0.036)*
T2: Bicycle lane (safe -> unsafe)		-3.699 (<0.001)***
T3: Wide centrelane marking (safe -> unsafe)		-1.521 (0.151)
T4: Parking (safe -> unsafe)		-2.830 (0.008)**
T5: No centrelane marking (safe -> unsafe)		-4.670 (<0.001)***
T5: Greenery (safe -> unsafe)		-5.192 (<0.001)***
R2 (conditional)	0.41	0.48
R2 (marginal)	0.17	0.30
AIC	2695.538	2636.640

Models explaining the effect of safe driving speed

- Treatment effects only
- Treatment effects, perception of safety and complexity

Average driving speed

- Safe driving speed is considered to be ~ 42 km/h

Treatment specific effects

- Roads with a **bicycle lane** are considered to have a **higher** safe driving speed
- Roads with **on-street parking** are considered to have a **lower** safe driving speed



RESULTS

SAFE & DESIRED SPEED



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Safety

- Individuals considering a treatment to be less safe, state lower safe driving speeds.
- This effect interacts with the treatment effects: treatment effects are higher but are offset by the safety perception

Goodness-of-fit

- Increases when safety perception is included (R^2 (marginal) for the fixed effects)

Introduction

Methods

Results

Conclusion

CONCLUSION AND DISCUSSION

Virtual reality

- Limited significant effects, small effects
- Driving speed in-line with the posted speed limit of 30 km/h

Safe & desired speed

- Well above 30 km/h (~42 km/h)
- Only on-street parking results in a speed reduction, other treatments result in an increase of desired and safe speed (e.g. bicycle lane)
- Can be attributed to perceived complexity and safety of a treatment
- Increasing the complexity or reducing perceived safety can, controversially, reduce driving speed.
- Either through design or introducing human factors

Driving style and practice

- Sensation-seeking results in a higher driving speed (1.5 to 2.5 km/h)
- Targeting these drivers through either sticks or carrots can yield the same effect as road design
- Nevertheless, such effects can usually only be measured for short distances

Future research

- Combinations of treatments, influencing the peripheral vision, perceived width and the perceived risk
- Randomization of treatments
- Varying traffic / pedestrian / cycling volumes within subject

GET IN TOUCH
FOR ANY QUESTION OR REMARKS

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Introduction

Methods

Results

Conclusion

METHODS

DRIVING SIMULATOR



RESULTS

SAMPLE

Variable	Value	n
Total		54
Gender	Male	28
	Female	26
Age	21–35 years	26
	36–50 years	19
	51–65 years	9