**Introduction**

- Transition from motorways to secondary roads and urban arterials

- Requires adaptation of driving behavior, especially a significant speed reduction

- Problems in terms of adapting speed might arise

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**Objectives**

1. Influence of speed in previous road environment (urban area 50km/h \(\rightarrow\) motorway 120km/h) on mean speed on a secondary road (~ speed adaptation)?

2. Influence of motorway exit ramp design or the intersection design on driving behavior (mean speed)?
   - 1. Throughout exit ramp?
   - 2. Immediately after the intersection?
   - 3. Over a longer distance after the intersection?

3. Influence of motorway exit ramp design or the intersection design on mental effort (Rating Scale of Mental Effort)?
Participants
- 135 volunteers
- 24 excluded: simulator sickness (14), technical problems (9), outlier (1)
- 111 participants in dataset
  - 72 men – 38 women
  - Between 19 and 68 years old
- Divided into 2 groups
  - Exit ramp group: 55
  - Intersection group: 56

Methodology

Exit ramp design
- 4 types of horizontal alignment
- Based on Dutch design standards (NOA, 2007)
- Exit length: 1220m

Methodology

Junction design
- 4 intersection types
- Participants must turn to the right
- No traffic on secondary road near intersection

Methodology

1. Practice session
- 4km rural – urban
- 7km motorway – rural – urban

Methodology

Simulator
- Fixed-base STISIM M400 with 180° parabolic screen
Methodology

Procedure

1. Practice session
2. Experimental session
   - Baseline scenario (7km)

Methodology

Rating Scale of Mental Effort

- Rating Scale of Mental Effort after each trip

   "Please indicate, by marking the vertical axis below, how much effort it took for you to complete the task you’ve just finished."

Objective

Q1. Influence of speed in previous road environment (urban area 50km/h vs. motorway 120km/h) on mean speed on a secondary road (~ speed adaptation)?

Results

Q1. Speed adaptation

Graph showing mean speed difference between urban area (50 km/h) and motorway (120 km/h).
Q2. Influence of motorway exit ramp design or the intersection design on driving behavior (mean speed)?

1. Throughout exit ramp?

2. Immediately after the intersection?

3. Over a longer distance after the intersection?
Q3. Influence of motorway exit ramp design or the intersection design on mental effort (Rating Scale of Mental Effort)?

**Objective**

- No significant difference between exit ramp design or intersection design
  
  $$p = 0.226$$
  
  $$p = 0.442$$

**Results**

**Discussion**

Q1. Speed adaptation?
- Higher mean speeds on secondary road after travelling on motorway (120 km/h) compared to urban area (50 km/h)
  
  - Mean speed difference over 5km = 1.1 km/h (1.5%)
  
  - Smaller effect than other studies concerning speed adaptation (3-7%) ~ other speed transitions

Q2.1 Influence of design on driving behavior throughout exit ramp?
- Exit ramp design influences mean speed throughout exit ramp
  
  - No gradual speed reduction ~ Calvi et al. (2012)
  
  - ‘Reset’ in curved exit ramp: 60 km/h
  
  - Limited ‘reset’ in straight exit ramp: 80 km/h
  
  - Yield controlled intersection is another ‘reset’

Q2.2 Influence of design on driving behavior immediately after intersection (1km)?
- Roundabout, traffic lights, yield controlled intersections: deceleration – acceleration
  
  - Acceleration lane: continuing speed (70 km/h)
  
  - Influence of intersection design is limited to 100m after intersection

Discussion
Q2.3 Influence of design on driving behavior over a longer distance after intersection (5km)?
- No significant differences in mean speed between
  - 4 exit ramp designs
  - 4 intersection types

Q3. Influence of design on mental effort?
- No significant differences in RSME-score
- Indication
  - Curved > straight exit ramp
  - Yield controlled > other intersection types
  - Further investigation is required

Discussion

Motorway exit ramp design and intersection design do influence mean speed
- ‘Reset’ throughout curved exit ramps
- ‘Reset’ at roundabout, traffic lights and yield controlled intersections
- No gradual speed reduction

Motorway – secondary road transitions:
  Speed adaptation!

Conclusion

Future research

Influence of design combinations with limited ‘reset’?
- Straight exit ramp + acceleration lane?
- Secondary road with 50 km/h speed limit?

Guidelines focus on speed reduction and traffic calming measures
- Still no gradual speed reduction
- How to influence speed perception (~ speed adaptation)?

Thank you!

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