MOTORCYCLE RIDER REACTION TIME AS RESPONSE TO VISUAL WARNINGS

Project of the Connected Motorcycle Consortium CMC

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What takes…

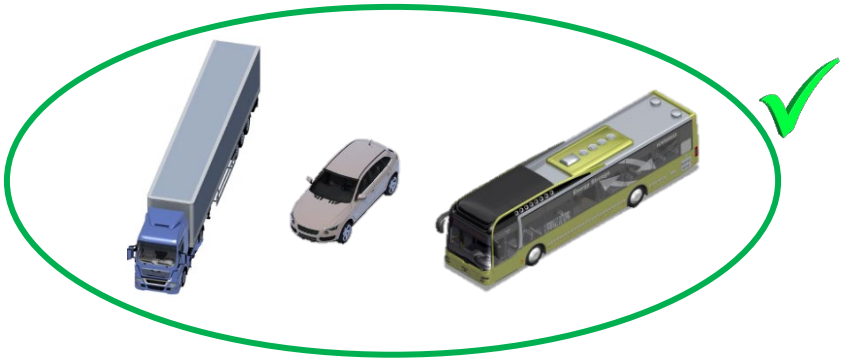
0.005 SECONDS…?

BACKGROUND & MOTIVATION

OVERVIEW

CMC's focus is on safety and comfort applications. Some of these applications run on the PTW and need an **interface** to communicate information to the rider (e.g., warning) at some point in time.

Research question:
Reaction times towards warnings for car drivers etc. are rather well investigated, but what is an appropriate estimate for such a reaction time as response towards a notification/ warning from the PTW of a PTW rider?

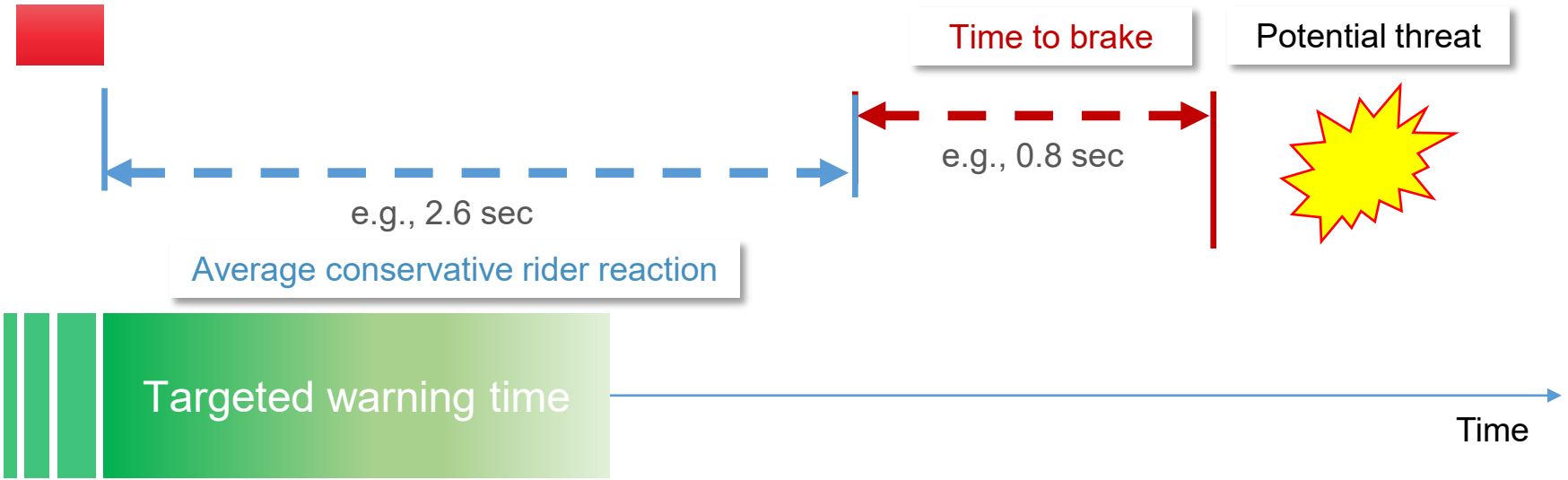


THE „TYPICAL REACTION“

PTW rider reaction times measured on different motorcycles while real riding will vary significantly due to a series of factors. Even the definition of “reaction” makes a huge difference.

STUDY DESIGN: CONSERVATIVE APPROACH

What is the “longest average rider reaction” under challenging conditions (a conservatively designed warning) we need to allow for the rider to perceive, understand and act?



Simplified schematic example for a certain speed and consequently braking distance/ time. All exemplary values.

METHODS

Data:

- Mock-up: BMW F800S with fully functional controls
- 220° field-of-view
- 7“ TFT-screens as mirrors
- 10“ touchscreen as dashboard
- 6-dof motion system
- 80 Nm force feedback steering torque
- Sound via helmet-mounted body shakers
- G-Vest rope-towing mechanism
- Camera-based headtracking

RIDER NOTIFICATION

Dashboard with generic visual warning (red rectangle).

- Conservative warning approach
  - Purely visual warning with a red non-flashing generic rectangle
  - No auditory and haptic warning
- The warning is triggered with a Time-to-Arrival TTA = 3.0 sec before the obstacle becomes visible.
- The warning is displayed for 3.0 sec and disappears automatically.

C-ITS APPLICATION DESCRIPTION

Schaubild CMC – vernetzte Motorradassistenz (VNr. 567)

C-ITS Assistenzsystem (Cooperative Intelligent Transport Systems)

Beispielsituation

Abbildung 1: Beispielsituationen zu Green Light Optimal Speed Advisory (links) oder Broken Down Vehicle Warning (rechts).

Hinweis im Cockpit

Abbildung 2: Beispielhafte Empfehlung (links) des Assistenzsystems (mit 40 km/h weiterfahren) und Warnung (rechts) des Assistenzsystems (bremsen) im Cockpit.

Angemessene Reaktion: Geschwindigkeit reduzieren bzw. anpassen

- Inform riders about the availability of the C-ITS application.
- Tell riders how the system generally works.
- Explain what the warning looks like and what an appropriate reaction would be in order to reduce ambiguity (time to interpret the warning in the situation would be an offset that is not of interest in this study).

RURAL TEST SCENARIO: ROAD WORKS/ BROKEN DOWN VEHICLE

Screenshot from rural scenario approach.

RURAL TEST SCENARIO: ROAD WORKS/ BROKEN DOWN VEHICLE

Screenshot from rural scenario warning period.

RURAL TEST SCENARIO: ROAD WORKS/ BROKEN DOWN VEHICLE

Screenshot from rural scenario threat visible/ warning off.

RURAL TEST SCENARIO: ROAD WORKS/ BROKEN DOWN VEHICLE

Screenshot from rural scenario situation.

RURAL TEST SCENARIO: ROAD WORKS/ BROKEN DOWN VEHICLE

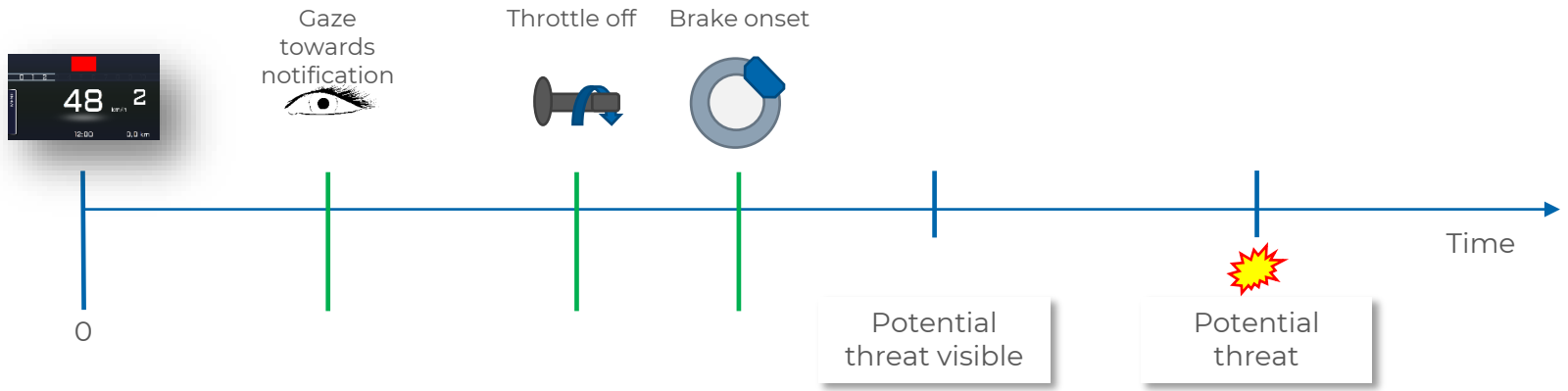
Screenshot from rural scenario passing situation.

URBAN TEST SCENARIO: CROSS TRAFFIC

Screenshot from urban scenario situation.

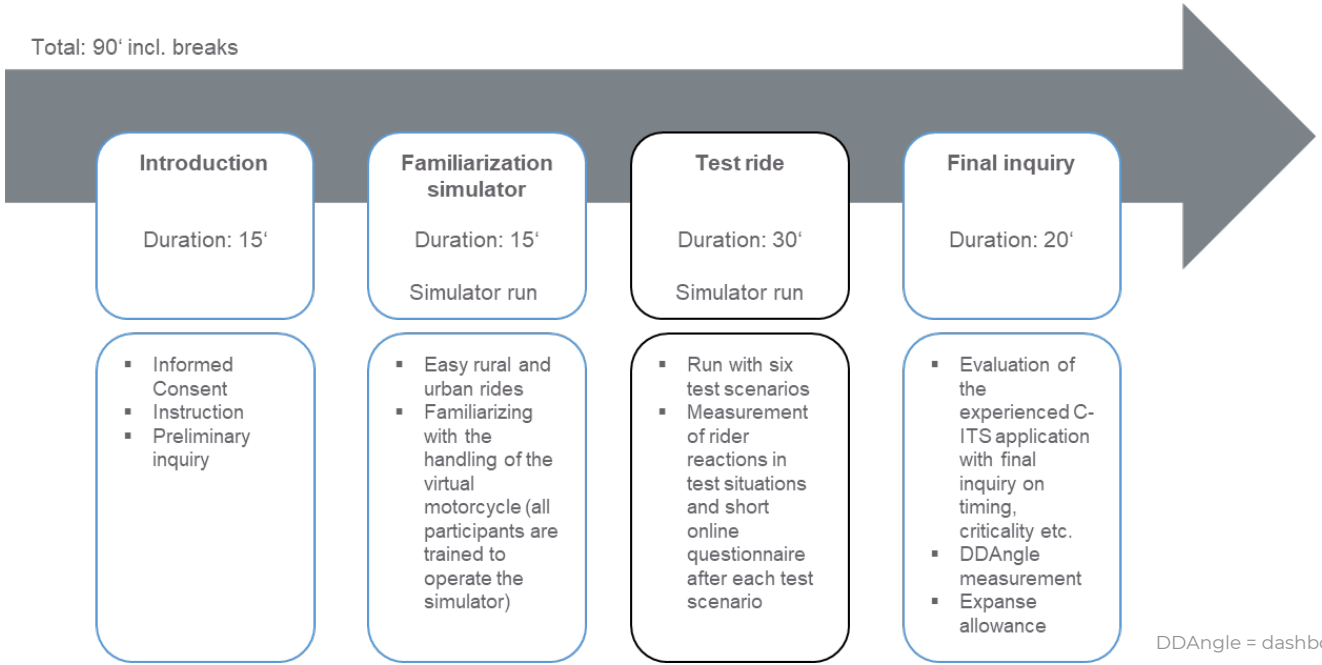
MEASURES

Please note: Not every type of reaction will be measurable for every rider in every scenario (e.g., if someone is not braking).



Schematic representation of different possibilities to calculate reaction times.

PROCEDURE



DDAngle = dashboard downward angle

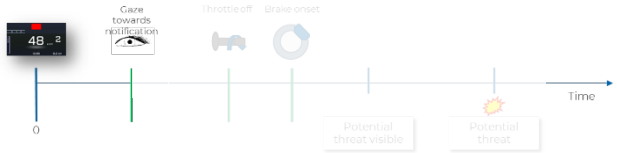
PANEL DESCRIPTION

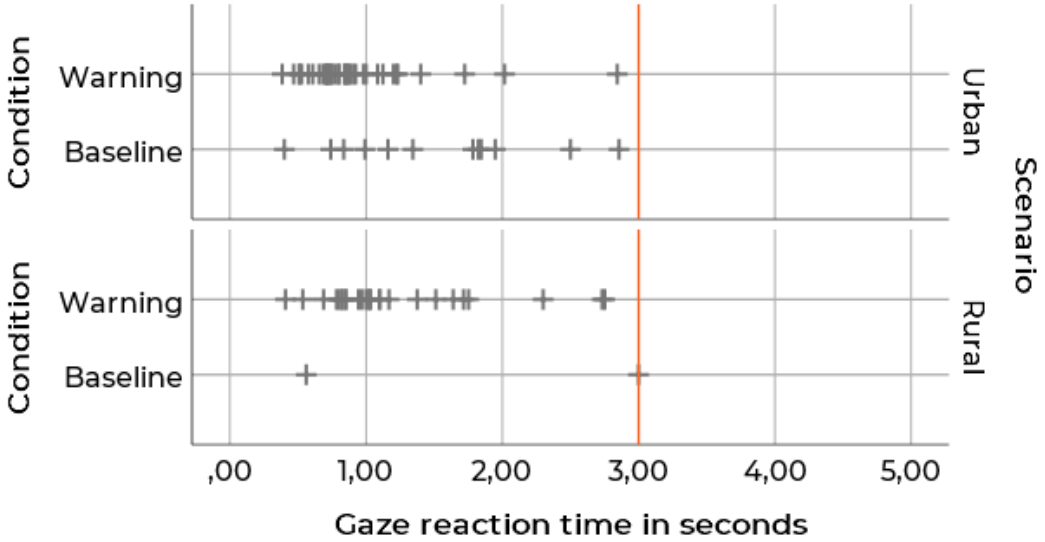
N = 24 participants (*n* = 3 female)

Parameter	*Mean*	*SD*	*Min*	*Max*
Age in years	36	12	20	60
Motorcycle mileage covered during last 12 months in km	3 854	3 232	500	12 000
Motorcycle mileage during lifetime in km	78 500	79 990	2 000	300 000

RESULTS

GAZE REACTIONS



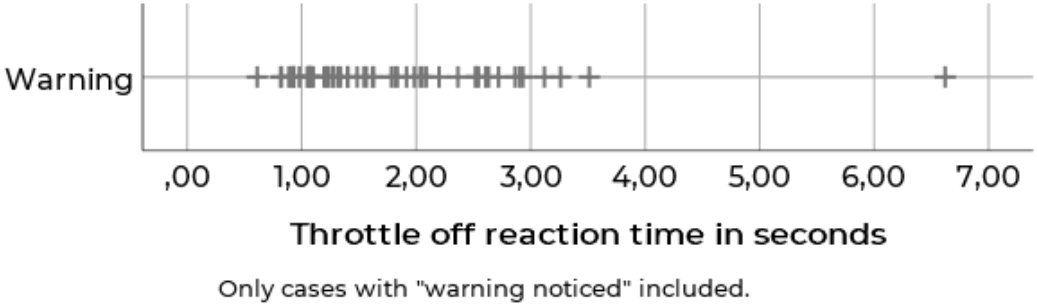


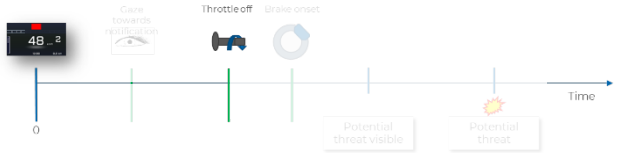
Condition	Baseline		Warning	
Scenario	urban	rural	urban	rural
N	12	2	42	26
Mean	1.52	1.78	0.91	1.22
Median	1.56	1.78	0.80	1.02
Min	0.40	0.56	0.38	0.41
Max	2.86	3.00	2.84	2.75
SD	0.74	1.73	0.44	0.61

+ indicates a single measurement

| the orange line indicates the point in time when the obstacle becomes visible and the warning disappears

DECELERATION REACTIONS

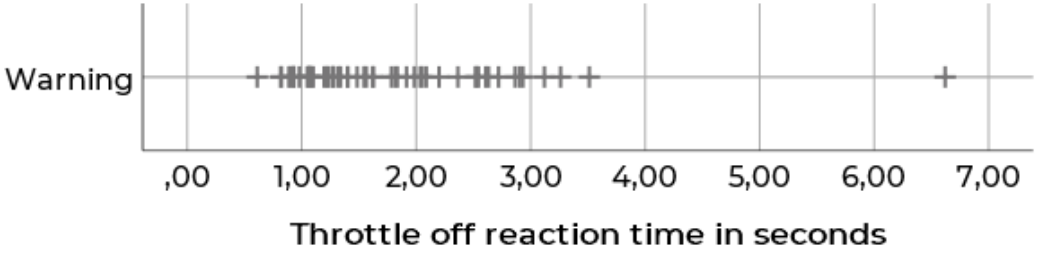




Condition	Throttle off
N	55
Mean	1.79
Median	1.51
Min	0.61
Max	6.62
SD	1.00

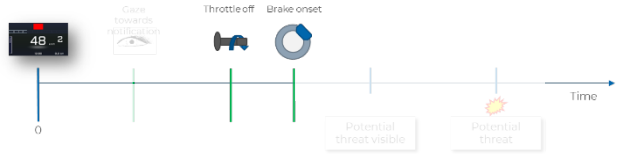
+ indicates a single measurement

DECELERATION REACTIONS



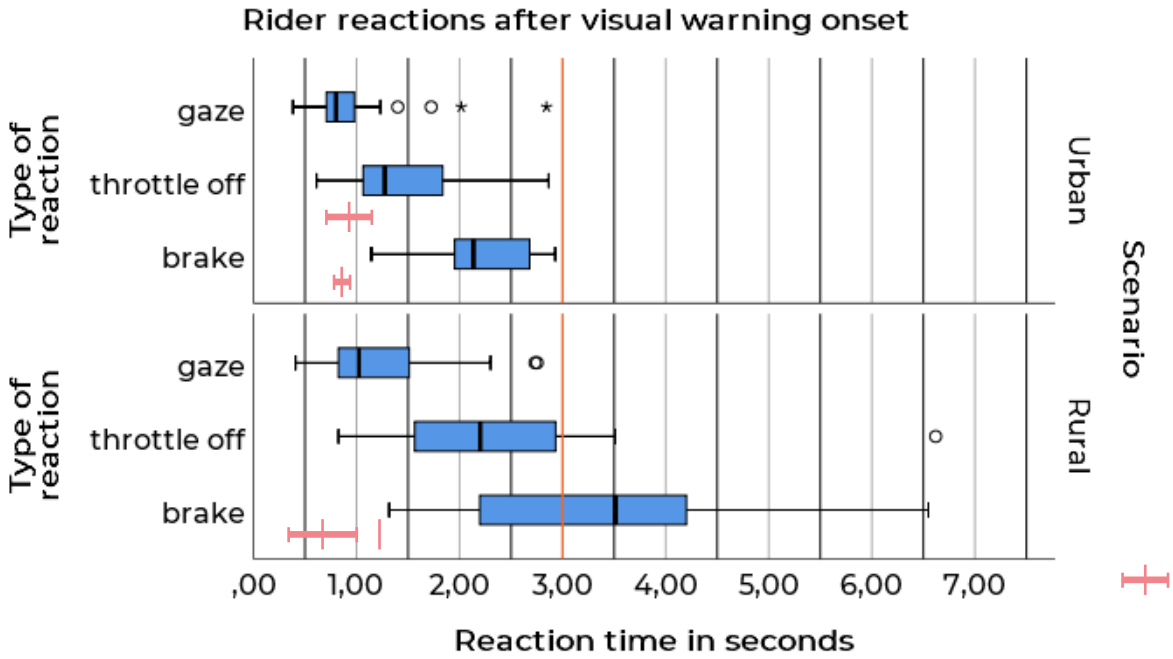
Only cases with "warning noticed" included.

+ indicates a single measurement



Condition	Throttle off	Brake onset
N	55	52
Mean	1.79	2.79
Median	1.51	2.49
Min	0.61	1.14
Max	6.62	6.55
SD	1.00	1.20

SUMMARIZED REACTION TIMES



Passenger car average reaction times from different publications e.g., ISO 15623:2013 (E), Bella & Silvestri, 2017, Winkler et al., 2015), Cao et al., 2010 showing *mean* (+/- 1*SD*)

| the orange line indicates the point in time when the obstacle becomes visible and the warning disappears. The boxes show median and interquartile range.

DISCUSSION & CONCLUSION

DISCUSSION

- **Scientific approach**
  - Limitations using a simulator (e.g., generalizability), but advantages prevail for the current status of research (e.g., scenario control, safety for the riders, standardization…)
  - Scenario design incl. dummy scenarios worked well.
  - No sequence effects and expectancy effects were observed.

- **Rider notification**
  - Even a conservative rider notification could be notified by a majority of riders.
  - An improved rider notification design (e.g., warning tone, visual signals closer to the natural line of sight etc.) should have the potential to create less missed warnings and potentially shorten reaction times further.
    In terms of safety and acceptance by the riders, this is extremely important.

CONCLUSION

- The distributions of rider reaction times with the given conservative rider notification concept create a **minimum benchmark** to be met by real-world notification concepts measured in a comparable setup.
- Even if it is rather impossible to identify absolutely comparable studies in the passenger car domain, the empirical evidence suggests a need for **PTW-specific rider reaction analysis** as more missed warnings seem to occur and the reaction times seem to differ (distribution, duration …).
- The distributions of rider reaction times can serve as important input to the tuning of **rider reaction time models**, which are e.g., required to create effectiveness estimations by means of traffic simulation.

Connected Motorcycle Consortium

Thanks to all CMC members contributing to this study

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THANK YOU FOR YOUR ATTENTION!

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