



Lane change driver reaction times

Industry input to ACSF IG
15th meeting
November 2017, Bonn



Intention of the Investigation

During lane change there are two important facts to consider in terms of timing.

- Reaction time (duration)
 - ❖ Literature is available
- Start point of the reaction time



Investigation to find out when this reaction time starts



Cover story for the test - Active Steering assistant

The investigation consists of three phases (for the test person*)

- **Set-up phase** : become familiar with the operation of the system/ car / environment and, in particular, to get used to drive on the target speed of 130 km / h.
- **natural driving behavior**, is to be recorded as a reference
- **different variants of a system for guidance** will be tested.

Boundary conditions:

- If the rest of traffic permits, drive on the straight sections on the left lane.
- If permissible, accelerate speedily to 130 km / h on the straight sections and keep this speed as good as possible.
- Please drive as you usually do in traffic.

*The test persons were selected through our driving simulator test management



Test procedure

The investigation consists of two phases

- **Set-up phase** : become familiar with the operation of the system/ car / environment and, in particular, to get used to drive on the target speed of 130 km / h.
- Test of (reaction time) the start point of reaction

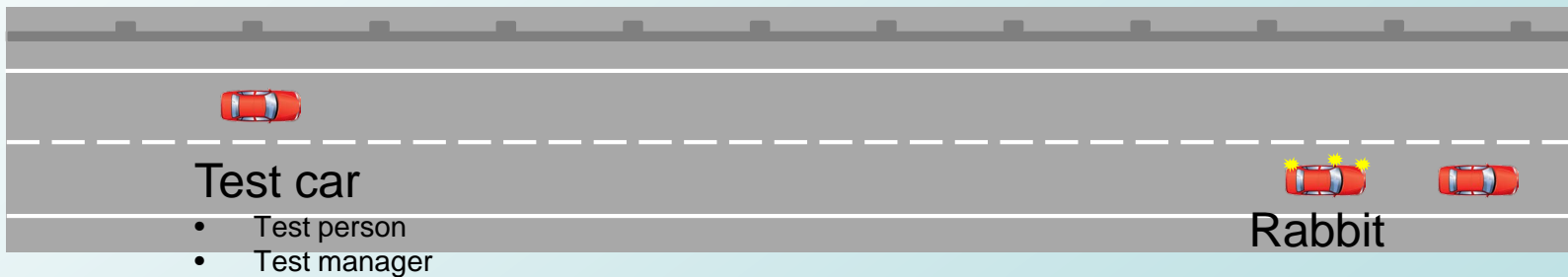
After the test the test persons were asked if the cover story was plausible.

- All test persons stated that they believed in the cover story.



Setup

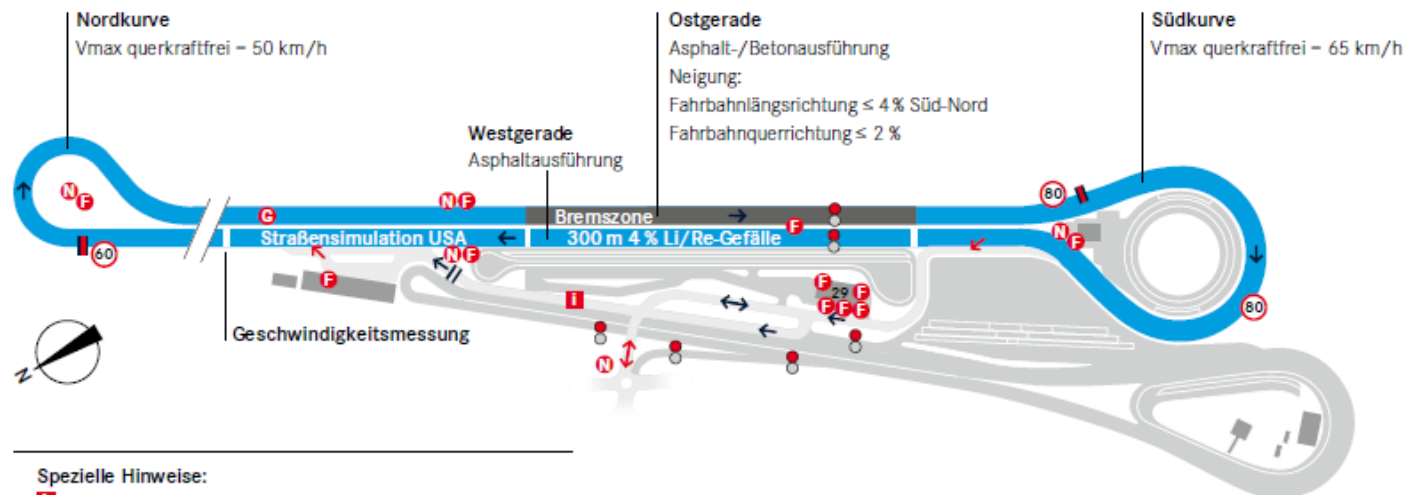
- Test car at 130 kph, rabbit at 80 kph - $dv=50$ kph (13,8 m/s)
- Test manager triggers the rabbit at approximately 96m (hidden trigger)
- Rabbit activate the direction indicator
- Rabbit drifts to the lane
- After 3 seconds rabbit crosses the line (distance TC and rabbit \rightarrow 55m)






Proving Ground in Sindelfingen









Schnellbahn (neue Einfahrbahn)

Geradenlänge ≥ 1.000 m, Fahrbahnbreite: 2 Spuren à 3,5 m



Spezielle Hinweise:

-  Beim Ein- und Ausfahren den fließenden Verkehr beachten!
-  Geschwindigkeitsbeschränkungen beachten!
-  Bremszonen und Halteverbote beachten!

 Notrufsäule
  Feuerlöscher
  Schranke
  Steilkurvensperrung
  Signalanlage
  Einfahrt/Ausfahrt
  Fahrtrichtung
 Geschwindigkeitsanzeige (zeitnah, variabel)



Instruction for the test manager

1. Drive 5 to 6 laps to get used to
2. After the acclimatization phase
 - ❖ “ Now we start with the second part, we want to record the natural driving behavior as a reference. Please drive as you usually do on the road.”
3. The rabbit must be overtaken twice by the test car.
4. In a suitable situation, set the lane change trigger by radio (walkie talkie).
5. After lane change
 - ❖ Trigger the measurement equipment
 - ❖ Test person ask to remember the behavior in this lane change situation
 - ❖ Fill test protocol
6. Move back to the parking position on the proving ground
7. Interview
8. Questions
9. Good bye



Test results

Test person	Distance TC – rabbit at the time of DI activation	Δv TC – rabbit at the time of DI activation	① Time DI activation – accelerator pedal	② Time accelerator pedal – brake pedal	①+② Time DI activation - brake pedal
1	93,17	14,81 m/s	0,467 s	0,317 s	0,784 s
2	101,35 m	13,99 m/s	0,910 s		
3	100,67 m	15,74 m/s	0,421 s	1,165 s	1,586 s
4	76,32 m	16,41 m/s	1,127 s	0,358 s	1,485 s
5	90,4 m	15,93 m/s	0,181 s	0,622 s	0,803 s
6	--	--	--	--	--
7	84,4 m	14,90 m/s	1,767 s	-	
8	--	--	--	--	--
9	82,2 m	15,13 m/s	0,864 s	1,042 s	1,906 s
10	82,5 m	14,37 m/s	1,059 s	0,505 s	1,564 s
11	91,50 m	14,34 m/s	0,404 s	0,676 s	1,080 s
12	91,83 m	14,35 m/s	0,373 s	1,162 s	1,535 s
13	86,72 m	14,36 m/s	0,385 s	0,732 s	1,117 s
14	86,64 m	14,81 m/s	1,260 s		
15	78,45 m	15,32 m/s	0,273 s	0,465 s	0,738 s
16	84,18 m	14,36 m/s	0,852 s	1,741 s	2,593 s
17	--	--	--	--	--
18	95,40 m	14,91 m/s	0,563 s	0,959 s	1,522 s
19	89,15 m	15,12 m/s	0,439 s	0,348 s	0,787 s

TC - Test car
DI - Direction indicator



Interview after the test

Question	total
The situation of the vehicle (lane change) in front of me, I received as ... scale from 1- uncritically up to 5- critically	
1	11
2	6
3	1
4	0
5	0
The beginning of the actual execution of the lane change of the vehicle I have moored to the following circumstance:	
Vehicle has set the turn signal	16
Vehicle moves in its own lane	4
Vehicle leaves its own lane (enters my lane)	1
Free answer (others)	
My reaction to this was due to the following circumstance:	
Vehicle has set the turn signal	10
Vehicle moves in its own lane	8
Vehicle leaves its own lane (enters my lane)	1
Free answer (others)	
Did you immediately act or wait ? (scale from 1- immediately acted up to 5- initially waited)	
1	9
2	2
3	1
4	4
5	1
My first reaction was:	
release the gas pedal	10
instant braking	4
Waiting	5



BACKUP



Cover story for the test - Active Steering assistant

The test consists of three phases

- We start with a **set-up phase** over a few laps, during which you first become familiar with the operation of the system and, in particular, get used to drive on the target speed of 130 km / h. During this phase you drive without the assistance of driver assistance systems.
- In the second part, the **natural driving behavior** with regard to the lane keeping is to be recorded as a reference. In addition, following the acclimatization phase, you will again drive a few laps without the assistance of driver assistance systems.
- Finally, in the third part you will experience **different variants of a system for guidance**. This is especially to assess the stability of the line keeping. Please rate in this part naturalness and comfort of the system. Please say immediately if you notice any commuting, leaving the center of the lane, or other effects, and how they affect you, how strongly you perceive them and whether you feel impaired by them.
 - While driving, please consider the following rules:
 - The rules and maximum speeds of the proving ground always apply.
 - If the rest of traffic permits, drive on the straight sections on the left lane.
 - If permissible, accelerate speedily to 130 km / h on the straight sections and keep this speed as good as possible.
 - Please drive as you usually do in traffic.
 - Note in particular that other vehicles may be traveling at the same time on the proving ground.
 - Safety comes first: As soon as you feel unwell, please inform your test administration immediately.
 - Please DO NOT use the DISTRONIC until explicitly requested to do so.



Interview after the test

Question	Probend 1	Probend 2	Probend 3	Probend 4	Probend 5	Probend 6	Probend 7	Probend 8	Probend 9	Probend 10	Probend 11	Probend 12	Probend 13	Probend 14	Probend 15	Probend 16	Probend 17	Probend 18	Summe	
The situation of the vehicle (lane change) in front of me, I received as ... scale from 1- uncritically up to 5- critically																				
1	1	0	0	0	0	0	1	1	0	1	1	1	1	1	1	0	1	1	1	11
2	0	1	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	6
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
The beginning of the actual execution of the lane change of the vehicle I have moved to the following circumstance:																				
8 Vehicle has set the turn signal	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	16
10 Vehicle moves in its own lane	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	4
11 Vehicle leaves its own lane (enters my lane)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
12 Free answer (others)	?? War in Gedanken																			
13 My reaction to this was due to the following circumstance:																				
14 Vehicle has set the turn signal	0	1	1	1	1	0	0	0	0	1	1	1	1	1	0	1	1	1	1	10
15 Vehicle moves in its own lane	0	0	0	0	1	1	1	1	1	0	0	0	1	1	0	1	1	0	0	8
16 Vehicle leaves its own lane (enters my lane)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
17 Free answer (others)	??																			
Did you immediately act or wait ? (scale from 1- immediately acted up to 5- initially waited)																				
19 1	0	1	0	1	1	1	0	0	0	1	1	1	1	1	0	0	0	0	0	9
20 2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
21 3	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
22 4	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	1	0	0	0	4
23 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
My first reaction was:																				
25 release the gas pedal	1	0	0	0	1	0	1	0	1	1	1	1	1	1	1	0	0	0	0	10
26 instant braking	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4
27 Waiting	0	0	0	0	0	1	1	1	0	0	1	0	0	0	0	1	1	1	0	5
Kommentar																				
29				Die angekreuzten Werte Umstände waren inkostent mit der Angabe der VP zum Reaktionszeitpunkt und zum VL-Protokoll	Die angekreuzten Werte Umstände waren inkostent															
30					Abwarten wirklich plausibel?			Reaktion müsste aber trotzdem erfolgt sein!?						Abwarten als erste Reaktion nicht plausibel						



Test persons

- The test persons were selected by the driving simulator test management.
- The test persons are all Daimler employees, because they need access to the proving ground.
- None of them is working in driver assistance systems.

Alter 20 - 44	männlich	weiblich	Alter 45 - 65	männlich	weiblich
10	4	6	8	8	0