Submitted by the experts of OICA

Informal Document: ACSF-15-08

Lane change driver reaction times

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

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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 behaviour,** 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

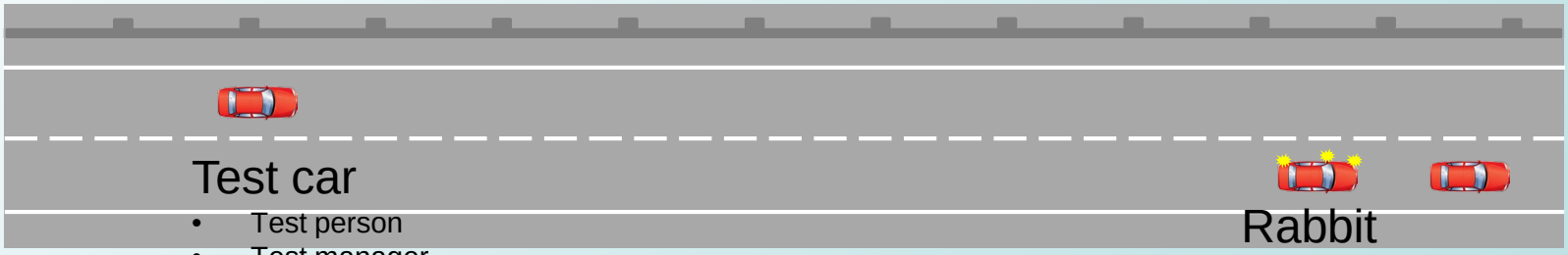
- **Set-up phase** : become familiar with the operation of the system/ car / environment and, in particular, to get used to drive on the target speed of 130 km / h.
- Test of (reaction time) the start point of reaction

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

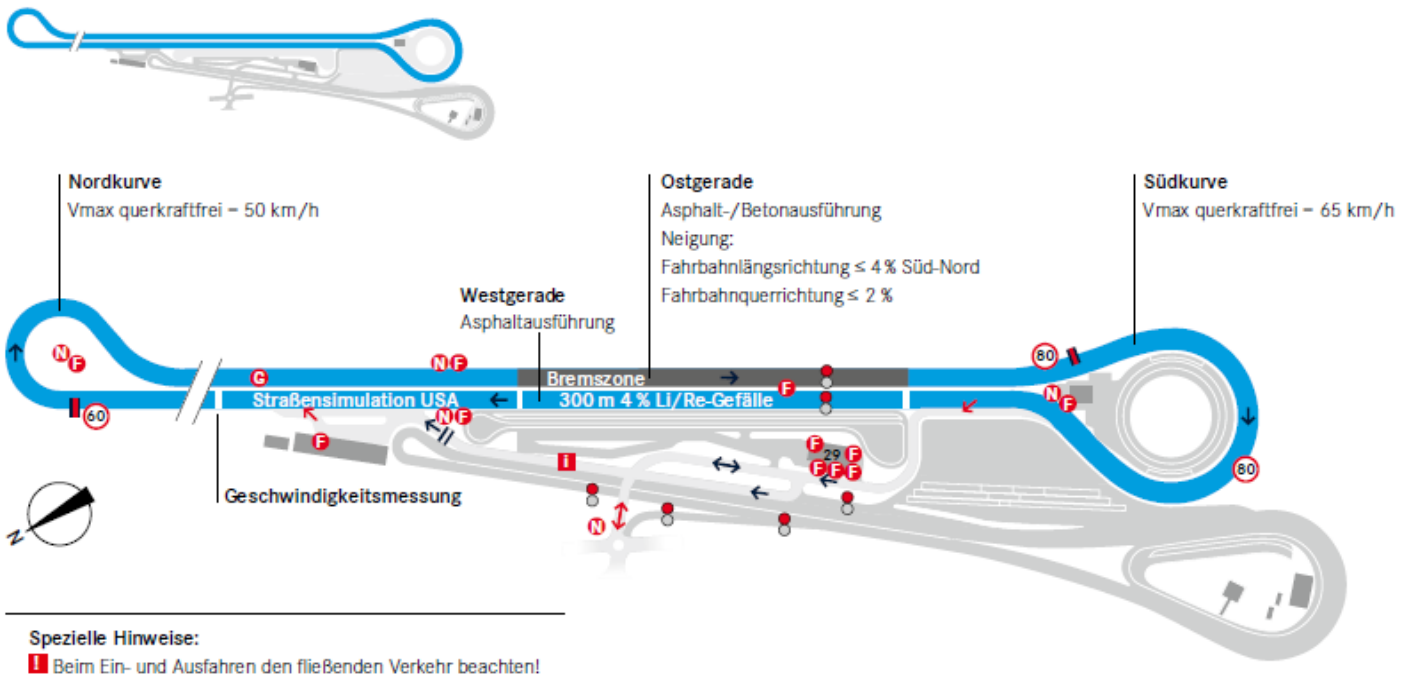
- Test car at 130 kph, rabbit at 80 kph - dv=50 kph (13,8 m/s)
- Test manager triggers the rabbit at approximately 96m (hidden trigger)
- Rabbit activate the direction indicator
- Rabbit drifts to the lane
- After 3 seconds rabbit crosses the line (distance TC and rabbit → 55m)



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!

N Notrufsäule F Feuerlöscher Schranke Steilkurvensperrung Signalanlage Einfahrt/Ausfahrt Fahrtrichtung

G Geschwindigkeitsanzeige (zeitnah, variabel)

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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 usally 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

Videos

See presentation <17-11-13_Videos_Szenario.pptx>

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

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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

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	Question	Proband 1	Proband 2	Proband 3	Proband 4	Proband 5	Proband 6	Proband 7	Proband 8	Proband 9	Proband 10	Proband 11	Proband 12	Proband 13	Proband 14	Proband 15	Proband 16	Proband 17	Proband 18	Summe
2	**The situation of the vehicle (lane change) in front of me, I received as ... scale from 1- uncritically up to 5- critically**																			
3	1	1	0	0	0	0	0	1	1	0	1	1	1	1	1	1	0	1	1	11
4	2	0	1	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	6
5	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
6	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	**The beginning of the actual execution of the lane change of the vehicle I have moored to the following circumstance:**																			
9	Vehicle has set the turn signal	0	1	1	1	1	0	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	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	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	0	0	0	0	0	1	1	1	0	1	0	1	1	1	10
15	Vehicle moves in its own lane	0	0	0	0	1	1	1	1	1	0	0	0	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	1	0	1
17	Free answer (others)	??																		
18	**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	0	1	1	1	0	0	0	9
20	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
21	3	0	0	0	0	0	0	1	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	4
23	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
24	**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	10
26	instant braking	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4
27	Waiting	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0	1	1	0	5
28	**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	Abwarten wirklich plausibel?		Reaktion müsste aber trotzdem erfolgt sein!?			Abwarten als erste Reaktion nicht plausibel								
30																				

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Test persons

- The test persons were selected by the driving simulator test management.
- The test persons are all Daimler employees, because they need acces 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

Test results

Auswertung Probandenversuch Reaktionszeit auf ausscherendes Fahrzeug														
Test Nr.	Datum	Uhrzeit	Fragebogen Nr.	Proband-Nr.	Abstand zum Ausscherfahrzeug zum Aktivierungszeitpunkt des Blinkers	Relativgeschwindigkeit zum Ausscherfahrzeug zum Aktivierungszeitpunkt des Blinkers	Zeit zwischen Blinkeraktivierung und Gaspedalreaktion = Reaktionszeit	Zeit zwischen Gaspedalreaktion und Bremspedalbetätigung	Zeit zwischen Blinken und Anlenken des Ausscherfahrzeugs	Messungsfile Probandenfahrzeug	Messungsfile Ausscherfahrzeug	Anmerkung	Bild Messung Reaktionszeit	Bild Messung Umsetzzeit
1	06.11.17	17:50 Uhr	0	1	93,17 m	14,81 m/s	0,467 s	0,317 s		001_20171106_195702_Manual_HDR___IDC_FR_ESP_idtb.dat		Jonas Firl, Synchronität im Rahmen der Messungenauigkeit gegeben	17-11-06_17-50_Proband1_Reak.png	17-11-06_17-50_Proband1_Umsetz.png
2	07.11.17	16:26 Uhr	1	2	101,35 m	13,99 m/s	0,910 s			001_20171107_183302_Manual_HDR___IDC_FR_ESP_idtb.dat		Proband bereits vorher von Gaspedal gegangen. Synchronität fraglich.	17-11-07_16-26_Proband2_Reak_Umsetz.png	
3	07.11.17	17:31 Uhr	2	3	100,67 m	15,74 m/s	0,421 s	1,165 s		002_20171107_193741_Manual_HDR___IDC_FR_ESP_idtb.dat	001_20171107_175003_Manual_HDR___IDC_FR_ESP_idtb.dat	Synchronität im Rahmen der Messungenauigkeit gegeben	17-11-07_17-31_Proband3_Reak.png	17-11-07_17-31_Proband3_Umsetz.png
4	07.11.17	18:24 Uhr	3	4	76,32 m	16,41 m/s	1,127 s	0,358 s		003_20171107_203128_Manual_HDR___IDC_FR_ESP_idtb.dat	002_20171107_184346_Manual_HDR___IDC_FR_ESP_idtb.dat	Synchronität im Rahmen der Messungenauigkeit gegeben	17-11-07_18-24_Proband4_Reak.png	17-11-07_18-24_Proband4_Umsetz.png
5	08.11.17	16:31 Uhr	4	5	90,4 m	15,93 m/s	0,181 s	0,622 s		002_20171108_183755_Manual_HDR___IDC_FR_ESP_idtb.dat	001_20171108_165010_Manual_HDR___IDC_FR_ESP_idtb.dat	Zeitlicher Versatz ca. 300 ms	17-11-08_16-31_Proband5_Reak.png	17-11-08_16-31_Proband5_Umsetz.png
6	08.11.17	17:30 Uhr	5	6	--	--	--	--		-	002_20171108_174936_Manual_HDR___IDC_FR_ESP_idtb.dat	keine Messdaten des Probandenfahrzeugs		
7	08.11.17	18:30 Uhr	6	7	84,4 m	14,90 m/s	1,767 s	-		001_20171108_203655_Manual_HDR___IDC_FR_ESP_idtb.dat	001_20171108_184907_Manual_HDR___IDC_FR_ESP_idtb.dat	Zeitlicher Versatz ca. 200 ms, kein Bremsvorgang	17-11-08_18-30_Proband7_Reak.png	-
8	09.11.17	16:26 Uhr	7	8	--	--	--	--		-	001_20171109_164538_Manual_HDR___IDC_FR_ESP_idtb.dat	keine Messdaten des Probandenfahrzeugs		
9	09.11.17	17:35 Uhr	8	9	82,2 m	15,13 m/s	0,864 s	1,042 s		002_20171109_194217_Manual_HDR___IDC_FR_ESP_idtb.dat	003_20171109_175437_Manual_HDR___IDC_FR_ESP_idtb.dat	2. Versuch bei Proband; Synchronität im Rahmen Messungenauigkeit gegeben	17-11-09_17-35_Proband9_Reak.png	17-11-09_17-35_Proband9_Umsetz.png
10	09.11.17	18:35 Uhr	9	10	82,5 m	14,37 m/s	1,059 s	0,505 s		003_20171109_204008_Manual_HDR___IDC_FR_ESP_idtb.dat	004_20171109_185226_Manual_HDR___IDC_FR_ESP_idtb.dat	Zeitlicher Versatz ca. 130 ms	17-11-09_18-33_Proband10_Reak.png	17-11-09_18-33_Proband10_Umsetz.png
11	10.11.17	16:30 Uhr	10	11	91,50 m	14,34 m/s	0,404 s	0,676 s		001_20171110_183708_Manual_HDR___IDC_FR_ESP_idtb.dat	001_20171110_164927_Manual_HDR___IDC_FR_ESP_idtb.dat	Zeitlich Versatz ca. 270 ms	17-11-10_16-30_Proband11_Reak.PNG	17-11-10_16-30_Proband11_Umsetz.PNG
12	10.11.17	17:28 Uhr	11	12	91,83 m	14,35 m/s	0,373 s	1,162 s		001_20171110_193509_Manual_HDR___IDC_FR_ESP_idtb.dat	002_20171110_174729_Manual_HDR___IDC_FR_ESP_idtb.dat	Zeitlicher Versatz ca. 180 ms	17-11-10_17-28_Proband12_Reak.PNG	17-11-10_17-28_Proband12_Umsetz.PNG
13	10.11.17	18:27 Uhr	12	13	86,72 m	14,36 m/s	0,385 s	0,732 s		002_20171110_203408_Manual_HDR___IDC_FR_ESP_idtb.dat	001_20171110_184629_Manual_HDR___IDC_FR_ESP_idtb.dat	Synchronität im Rahmen der Messungenauigkeit gegeben	17-11-10_18-27_Proband13_Reak.PNG	17-11-10_18-27_Proband13_Umsetz.PNG
14	13.11.17	16:25 Uhr	13	14	86,64 m	14,81 m/s	1,260 s			001_20171113_183153_Manual_HDR___IDC_FR_ESP_idtb.dat	001_20171113_164412_Manual_HDR___IDC_FR_ESP_idtb.dat	Proband hat bereits vorher Gaspedalstellung reduziert. Zeitlicher Versatz ca. 150 ms	17-11-13_16-25_Proband14_Umsetz.PNG	
15	13.11.17	17:29 Uhr	14	15	78,45 m	15,32 m/s	0,273 s	0,465 s		002_20171113_193611_Manual_HDR___IDC_FR_ESP_idtb.dat	002_20171113_174836_Manual_HDR___IDC_FR_ESP_idtb.dat	Zeitlicher Versatz nicht ermittelbar - großer Versatz kann ausgeschlossen werden.	17-11-13_17-29_Proband15_Reak.PNG	17-11-13_17-29_Proband15_Umsetz.PNG
16	13.11.17	18:21 Uhr	15	16	84,18 m	14,36 m/s	0,852 s	1,741 s		003_20171113_202828_Manual_HDR___IDC_FR_ESP_idtb.dat	003_20171113_184049_Manual_HDR___IDC_FR_ESP_idtb.dat	Gaspedalverlauf nicht eindeutig deshalb WorstCase-Zeiten verwendet	17-11-13_18-21_Proband16_Reak.PNG	17-11-13_18-21_Proband16_Umsetz.PNG
17	14.11.17	16:25 Uhr	16	17	--	--	--	--		001_20171114_183241_Manual_HDR___IDC_FR_ESP_idtb.dat	001_20171114_164506_Manual_HDR___IDC_FR_ESP_idtb.dat	Telekamera anfangs ausgefallen, Dokukamera geblendet, Startzeitpunkt Blinktakt nicht ermittelbar	--	--
18	14.11.17	17:29 Uhr	17	18	95,40 m	14,91 m/s	0,563 s	0,959 s		002_20171114_193625_Manual_HDR___IDC_FR_ESP_idtb.dat	002_20171114_174846_Manual_HDR___IDC_FR_ESP_idtb.dat	Telekamera ausgefallen, Auswertung via Dokukamera, zeitlicher Versatz ca. 220 ms	17-11-14_17-29_Proband18_Reak.png	17-11-14_17-29_Proband18_Umsetz.png
19	14.11.17	18:28 Uhr	18	19	89,15 m	15,12 m/s	0,439 s	0,348 s		003_20171114_203531_Manual_HDR___IDC_FR_ESP_idtb.dat	003_20171114_184751_Manual_HDR___IDC_FR_ESP_idtb.dat	Telekamera ausgefallen, Auswertung via Dokukamera, zeitlicher Versatz ca. 300 ms	17-11-14_18-28_Proband19_Reak.png	17-11-14_18-28_Proband19_Umsetz.png
										Prämissen: Gemessen wird ab der ersten Bildaufnahme, auf der ein Blinken zu erkennen ist, bis zur ersten wesentlichen Veränderung an der Gaspedalstellung	Prämissen: Gemessen wird ab der ersten wesentlichen Gaspedalstellungsänderung bis zur aufsteigenden Flanke des Bremspedalschalters			

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