TOC-Rating: Rater Training

Definitions of the events to be coded

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• **Objective of the training programme**

• **Methods of assessment**
  – Hierarchic assessment process
  – Coding sheet
  – Principles of assessment

• **Explanations of the events to be coded**
Objectives of the training programme

• Learning how to use the expert rating procedure for the assessment of the controllability of take-over situations in conditionally automated driving

• Learning the events to be coded within the observation categories by means of sample videos
Overview

• **Objective of the training programme**

• **Methods of assessment**
  – Hierarchic assessment process
  – Coding sheet
  – Principles of assessment

• **Explanations of the events to be coded**
Hierarchic assessment process

1. Was the situation controllable?
   - yes
   - no → Not controllable → 10 Collision/Loss of vehicle control

2. Was the situation safety-critical?
   - yes
   - no → Dangerous/non-acceptable risk → 9 Severe endangerment/strong driver intervention

3. Was the take-over quality good?
   - yes
   - no → Driving errors/acceptable risk → 6 Severe impairments in vehicle control

4. Was the take-over performance perfect?
   - yes
   - no → No driving errors/imperfections → 3 Good performance, with imperfections

5. Perfect performance → 1 Very good performance
Overview

• Objective of the training programme
• Methods of assessment
  – Hierarchic assessment process
  – Coding sheet
  – Principles of assessment
• Explanations of the events to be coded
• Criteria for the assessment of the take-over situation
  – Braking
  – Longitudinal control
  – Lateral control
  – Lane change/lance choice
  – Securing/communicating
  – Vehicle operation
  – Driver’s facial expression (secondary criterion)
## Coding sheet for take-over situations

<table>
<thead>
<tr>
<th></th>
<th>Faultless</th>
<th>Imprecisions</th>
<th>Driving Errors</th>
<th>Endangerment</th>
<th>Not controllable Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Braking response</td>
<td></td>
<td></td>
<td>too strong</td>
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<td>collision</td>
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<td>too weak</td>
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<td>lane departure/ leaving road</td>
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<td>too late</td>
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<td>loss of vehicle control</td>
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<tr>
<td>Longitudinal vehicle control</td>
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<td></td>
<td>safety-distance too low</td>
<td>endanger others</td>
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<td></td>
<td>inadequate speed</td>
<td>endanger self</td>
<td></td>
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<tr>
<td>Lateral vehicle control</td>
<td></td>
<td>jerky steering event</td>
<td>safety-distance too low</td>
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<td></td>
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<td>imprecise lane keeping</td>
<td>strong oscillation</td>
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<td>crossing lane markings</td>
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<td>hesitant/ interrupted</td>
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<td>wrong lane</td>
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<tr>
<td>Securing/ communication</td>
<td></td>
<td>unnecessary/ wrong use of indicator</td>
<td>missing/ too late use of indicator</td>
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<td>too late control glance</td>
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<tr>
<td>Vehicle operation</td>
<td></td>
<td>imprecisions</td>
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<td>problems</td>
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<tr>
<td>Driver facial expression</td>
<td>visible emotions</td>
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</tbody>
</table>

1  2  3  4  5  6  7  8  9  10

comment:
• **Objective of the training programme**

• **Methods of assessment**
  – Hierarchic assessment process
  – Coding sheet
  – Principles of assessment

• **Explanations of the events to be coded**
Preparations for the rating

- **Preparing video material of the take-over situations**
  - Including various views (e.g. driving scenario, control elements, driver)
  - Defining the beginning and the end of the take-over scenario (assessment of comparable sections)

- **Advance information on the system behaviour**
  - Function and operation of the system are known to the rater (e.g. type of activation)

- **Defining the “ideal solution” for the situation**
  - For example regarding the best possible reaction
The rating procedure

1. Assess the overall situation (driver + system + situation)

2. Watch the video several times
   - First without seeing the driver view to avoid any influence from the driver’s expression/posture/gestures on the evaluation
   - Include “driver’s expression” only after the first assessment

3. Hierarchic decision: uncontrollable/endangering or not?
   - If there is an uncontrollable event or an endangerment: find causes by error categories (prevent any loss of information)
   - If there is no uncontrollable event or endangerment: coding of the driving errors/uncertainties

4. Separate possibility to describe causes of uncontrollable events/endangerments in the comment box
   - e.g. distracted by a non-driving activity
• Guidelines for the rating grades
  – ≥ 1 uncontrollable event \( \Rightarrow \) rating = 10
  – ≥ 1 endangerment \( \Rightarrow \) rating ≥ 7
  – ≥ 1 driving error \( \Rightarrow \) rating ≥ 4
  – ≥ 1 imprecision \( \Rightarrow \) rating ≥ 2
  – Perfect \( \Rightarrow \) rating = 1

• Discretionary powers:
  – The number and degree of severity of the imprecisions/errors define the rating grade within the rating sections without defining a specific rating grade for a specific number.
  – In case of a high accumulation and/or particular severity of uncertainties, the rating grade of the category above (4-6) may be attributed.
• If an error results from another one, both errors must be coded
  – Example: too strong braking resulting from late braking
  – The higher rating grade does not have to be attributed (→ Discretionary powers)

• Severity of an error can vary depending on the situation
  – For example depending on whether there was any other traffic or not
    and whether the error had any consequences

• But: It is the actual situation that must be evaluated
  – No “what-if” judgements
Objective of the training programme

Methods of assessment
  – Hierarchic assessment process
  – Coding sheet
  – Principles of assessment

Explanations of the events to be coded
• Depiction and explanations of the events to be coded by means of sample videos

• Separate depiction according to the observation categories and evaluation criteria

• Related sample videos: http://toc-rating.de/schulungsunterlagen/
UNCONTROLLABLE

- Collison
- Leaving the road
- Loss of vehicle control
- Defined fail criterion of the test
### Uncontrollable - Definition

**Definition**
Endangerment scenario **not controlled** by the driver

<table>
<thead>
<tr>
<th>Collison</th>
<th>• Collision with another road user or an obstacle</th>
</tr>
</thead>
</table>
| Leaving the road          | • Leaving the **road** (i.e. the tarred part of the road, includes all lanes and the hard shoulder)  
  - Criterion: centre of gravity of the car must leave the road  
  • **Applicability:** If the vehicle leaves the road with less than its centre of gravity (e.g. tyres only)  
  → Crossing lane markings |
| Loss of vehicle control   | • Loss of control of the vehicle  
  - The vehicle spins  
  - The rear of the car swerves  
  - The vehicle swerves across several lanes |
| Fail criterion            | • A pre-defined fail criterion, specified by the head of studies before the beginning of the test.  
  - An intolerable behaviour, e.g. running over traffic cones, triggering an emergency stop manoeuvre, exceeding a defined performance value |
ENDANGERMENTS

Situation implying an unacceptable risk:

- Endangering others
- Endangering self
**Endangering - Definition**

**Definition**
Situation with an **inacceptable risk** for the driver (danger to self) and/or other road users (danger to others)
- **Extent of danger to self/others** defined by the safety distance; close space/time distance (longitudinal/lateral) to another road user or to an obstacle
  AND/OR
- Intensity of the **driver’s intervention** (longitudinal/lateral control)

If both aspects are present in different intensities, the stricter criterion is to be used for the rating.

**Special case: Severely non-compliant behaviour**

<p>| | |</p>
<table>
<thead>
<tr>
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</thead>
</table>
| 7 | • **Minor** endangerment AND  
   • **No** or **insignificant** reaction of the driver; no obvious “emergency” reaction |
| 8 | • **Moderate** endangerment OR  
   • **Minor** endangerment AND reaction of the driver **exceeding the standard range** |
| 9 | • **Severe** endangerment OR  
   • **Minor/moderate endangerment** AND **emergency reaction** by the driver (longitudinal/lateral intervention at the limits of what is possible for the driver) |
BRAKING

Mistake:

- Braking too strong
- Braking too weak
- Braking too late
- Missing brake reaction
**Braking - Definition (1/2)**

**Definition**
Activation of the brakes not appropriate for the situation (too strong/weak/late, no braking) or clearly harder than the usual braking power (**harder than the standard range**).

| too strong | • Intensity of the deceleration is **too high**  
|           |   – Possible consequences: unnecessary high speed reduction and/or braking to standstill |
| too weak  | • Intensity of the deceleration is **too low**, a higher deceleration would have been more appropriate for the situation.  
|           |   – Possible consequences: quick closing up to the obstacle/endangering  
|           |   – To avoid negative consequences, the driver needs  
|           |     ▪ to brake hard or  
|           |     ▪ carry out an additional action (e.g. avoiding) |
**Braking - Definition (2/2)**

**Definition**
Activation of the brakes not appropriate for the situation (too strong/weak/late, no braking) or clearly harder than the usual braking power (**harder than the standard range**).

**too late**
- The driver brakes so late (in relation to the obstacle) that there are negative consequences (e.g. undercut of safety distance/endangerment/collision)
  - Possible consequences: to avoid negative consequences, the driver needs
    - to brake hard or
    - carry out an additional action (e.g. avoidance)

**Missing brake reaction**
- Driver does not brake when necessary
  - Possible consequences:
    - Inadequate speed
    - Undercut of safety distance/endangerment/collision with an obstacles in the ego-lane
    - Undercut of safety distance/endangerment/collision and/or wrong lane, if instead of decelerating correctly, driver changes lanes
LONGITUDINAL CONTROL

Mistake:

• Undercut of safety distance
• Inadequate speed
## Longitudinal Control - Definition

### Definition
Mistake in keeping longitudinal distance and speed

<table>
<thead>
<tr>
<th>Undercut of safety distance</th>
<th>Insufficient safety distance at the front or back</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>as an explanation for the endangerment</td>
</tr>
<tr>
<td></td>
<td>possible even without endangering (slightly insufficient safety distance)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Inadequate speed</th>
<th>The speed is <strong>not appropriate</strong> for the situation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>too fast</strong></td>
</tr>
<tr>
<td></td>
<td>- can be the effect of braking too late/weak/missing brake reaction</td>
</tr>
<tr>
<td></td>
<td>- exceeding speed limits</td>
</tr>
<tr>
<td></td>
<td><strong>too slow</strong></td>
</tr>
<tr>
<td></td>
<td>- can be the effect of a deceleration that was too powerful</td>
</tr>
<tr>
<td></td>
<td>- extremely below the applicable speed limit</td>
</tr>
<tr>
<td></td>
<td>- obstructing the traffic arriving from behind; cars driving behind must decelerate</td>
</tr>
</tbody>
</table>
LATERAL CONTROL

Uncertainty:
• Jerky steering
• Imprecise lane keeping

Mistake:
• Undercut of safety distance
• Strong oscillation
• Crossing lane markings
## Lateral Control - Definition (1/3)

**Definition**
Complaints about lane keeping and steering

<table>
<thead>
<tr>
<th>Uncertainty</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Jerky steering</strong></td>
</tr>
<tr>
<td>• Strong, fast steering movement (to one side or to both sides)</td>
</tr>
<tr>
<td>• Possible consequences: impaired lane keeping (imprecise, oscillation, crossing lane markings)</td>
</tr>
<tr>
<td>• <strong>Applicability:</strong> even if, due to the system, a powerful steering intervention is necessary to deactivate the system</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Imprecise lane keeping</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Imprecise, imperfect keeping to the lane, the intensity being less than for “strong oscillation”, i.e. without getting close to the road marking;</td>
</tr>
<tr>
<td>• Drifting towards one or both sides within one lane;</td>
</tr>
<tr>
<td>• Can be the result of oversteering to deactivate the system</td>
</tr>
<tr>
<td>• <strong>Applicability:</strong></td>
</tr>
<tr>
<td>‒ if the driver also crosses the lane markings, but the events can be separated from each other,</td>
</tr>
<tr>
<td>‒ then both complaints must be considered</td>
</tr>
<tr>
<td>‒ when the imprecise lane keeping goes on for a longer period of time,</td>
</tr>
<tr>
<td>‒ it must be considered in the rating grade</td>
</tr>
</tbody>
</table>
Definition
Complaints about lane keeping and steering

Mistake

Strong oscillation

• Deviation from the centre of the lane, the intensity being higher than for “imprecise lane keeping”, i.e. the car comes close to the road marking
• Drifting to one or both sides within the lane, without a tyre overstepping the road marking (tyres may be on the road marking)
• Can be the result of overriding the steering to deactivate the system

Applicability:
• if the driver also crosses the lane marking, but the events can be separated from each other, then both mistakes must be considered
• when the swerving goes on for a longer period of time, it must be considered in the rating grade
### Lateral Control - Definition (3/3)

#### Definition
Complaints about lane keeping and steering

#### Mistake

| Crossing lane markings | • The vehicle crosses the lane marking (tyres must pass the marking) without the driver changing lanes (i.e. returning to the original lane) | • Possible on one or on both sides | • Can be the result of overriding the steering to deactivate the system | • **Applicability:**  
  - If this happens several times, it must be considered in the rating grade  
  - **Not applicable**  
    - if the driver is supposed to follow new yellow road markings, but remains on the “old” lane → “wrong lane”  
    - if the marking needs to be crossed during a lane change  
    - if there are no road markings (cannot be assessed due to missing criteria) |

| Undercut of safety distance | • Insufficient safety distance  
  - as an explanation for the endangerment  
  - also possible without endangerment |
LANE CHANGE/ LANE CHOICE

Mistake:
- Hesitant/interrupted lane change
- Late lane change
- Missing lane change
- Wrong lane

<table>
<thead>
<tr>
<th>Faultless</th>
<th>Imprecisions</th>
<th>Driving Errors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Braking response</td>
<td></td>
<td>too strong, too weak, too late, missing</td>
</tr>
<tr>
<td>Longitudinal vehicle control</td>
<td></td>
<td>safety-distance too low, inadequate speed</td>
</tr>
<tr>
<td>Lateral vehicle control</td>
<td></td>
<td>jerky steering event, imprecise lane keeping, safety-distance too low, strong oscillation, crossing lane markings</td>
</tr>
<tr>
<td>Lane change/lane choice</td>
<td></td>
<td>hesitant/ interrupted, too late, missing, wrong lane</td>
</tr>
<tr>
<td>Securing/ communication</td>
<td></td>
<td>unnecessary/ wrong use of indicator, missing/ too late use of indicator, missing/ too late control glance</td>
</tr>
<tr>
<td>Vehicle operation</td>
<td></td>
<td>imprecisions, problems</td>
</tr>
<tr>
<td>Driver facial expression</td>
<td></td>
<td>visible emotions</td>
</tr>
</tbody>
</table>

1 2 3 4 5 6
Lanchange/ Lane choice - Definition (1/3)

Definition
Errors during change of lanes or selection of lanes

**Hesitant lane change/ interrupted lane change**

The driver shows an undecided behaviour when changing lanes

- **Hesitant**: driver carries out the change of lanes hesitantly or waits too long to change lanes after having announced the change of lanes by indicating or looking into the mirror
- **Interrupted**: driver aborts a change of lanes already initiated (by setting the indicator/approaching the road marking)

- **Applicability**:
  - if there are also complaints about the lateral control, but the events can be separated from each other,
  - then both complaints must be considered
  - **do not attribute**: if the vehicle stopped
  - “missing lane change”

**Late lane change**

- The driver initiates the change of lanes too late (in spation relation to the reason for changing lanes, e.g. an obstacle)
- **Applicability**:
  - means the space component, not the time component
  - also attribute this error, if the system asks the driver to take over only shortly before the obstacle resulting automatically in a late change of lanes (totality of system, driver etc.)
Definition
Errors during change of lanes or selection of lanes

**Missing lane change**

- A necessary and possible lane change (i.e. possible without endangering others or failing to give way) is not performed, so that the driver must stop (e.g. behind an obstacle).
- **Applicability:**
  - **Not applicable**, if the driver must follow the new “yellow” road marking, e.g. at a construction site, and the driver sticks to the old marking, overstepping the yellow line → “wrong lane”
Lane change/ Lane choice - Definition (3/3)

Definition
Errors during change of lanes or selection of lanes

Wrong lane
- During or after the take-over situation, the driver is not in the “correct” lane according to traffic rules (e.g. violating the rule to drive on the right, driving on the hard shoulder, overtaking on the right lane).
- Is caused
  - either by a missing lane change (lane ends, driver continues on the hard shoulder) or by
  - unnecessary lane-changes
- **Applicability:**
  - if there are no road markings, the situation cannot be assessed due to missing criteria
  - not applicable if the situation is constructed in such a way, that on a road with several lanes the driver using the right lane could lead to more errors/endangerments (e.g. pedestrians on the road → left lane is better)
SECURING / COMMUNICATION

- **Imprecision:**
  - Unnecessary use of the indicator/ wrong use of indicator

- **Errors:**
  - Missing use of indicators/ too late use of indicators
  - Missing /too late control glance

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<td>strong oscillation</td>
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<td></td>
<td>visible emotions</td>
</tr>
</tbody>
</table>

1 2 3 4 5 6
Definition
Complaints in the securing behaviour and the communication with other road users

Uncertainty

Unnecessary use of the indicator/wrong use of the indicator

• Driver indicates unnecessarily although they do not change lanes; or indicates in the wrong direction
• Possible reasons:
  – problems operating the indicator
  – driver wanted to deactivate the system
## Securing/Communication - Definition (2/2)

### Definition
Complaints in the securing behaviour and the communication with other road users

### Mistake

<table>
<thead>
<tr>
<th>Missing use of indicators/too late use of indicators</th>
<th>• When changing lanes/avoiding obstacles, the driver does <strong>not</strong> indicate or indicates <strong>too late</strong> (only when actually changing lanes, so that the warning function of the indicator does not work, e.g. tyres already touch the road marking)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Severity depends on whether there is any other traffic or not</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Missing control glance/too late control glance</th>
<th>• Driver does not look to check (look into the mirror, over the shoulder, on the road) or looks too late (when having initiated the manoeuver already, or even later), so that the securing function is no longer fulfilled</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Severity depends on whether there is any other traffic or not</td>
<td></td>
</tr>
<tr>
<td>• <strong>Applicability:</strong></td>
<td></td>
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<tr>
<td>• Looking over the shoulder: since it is not unusual for drivers to forget to look over their shoulders in <strong>simulator studies</strong>, it should be decided specifically for every study (e.g. depending on the instructions/field of sight) of whether the behaviour is to be classified as an error</td>
<td></td>
</tr>
<tr>
<td>• Do not attribute an error in cases of “looked but failed to see” (what counts is whether the driver looked)</td>
<td></td>
</tr>
</tbody>
</table>
VEHICLE OPERATION

• Imprecisions
  – Imprecisions: Imperfections at handling vehicle and system control
    ▪ Single-handed take-over
    ▪ Take-over with occupied hand(s)
    ▪ Uncertainties at solving the take-over situation

• Errors:
  – Problems at handling vehicle and system control
    ▪ Unnecessary/unnecessary strong use of pedals
    ▪ Problems deactivating the system
Vehicle Operation - Definition (1/3)

**Definition**
Complaints when solving take-over situation with regards to the vehicle operation

---

**Uncertainty**

**Single-handed take-over**
- The driver only grabs the steering wheel with one hand when taking over
- The hand not touching the steering wheel can be free or occupied

**Take-over with occupied hand(s)**
- When taking over, the driver grabs the steering wheel with both hands, but one or both hands are still occupied

**Uncertainties at solving the take-over situation**
- Driver is insecure how to deactivate the system
  - e.g. problems finding the correct button or the respective possibility for deactivating the system; initial searching gesture, but the **correct** one was selected
- Driver is uncertain whether accelerating or braking is the correct reaction, before deciding on the **correct** action
Definition

Complaints when solving take-over situation with regards to the vehicle operation

Mistake

Problems when solving take-over situation

Unnecessary/unnecessary strong use of pedals

- **Context: vehicle operation**
  - pedals mixed up
  - simultaneous activation of more than one pedal
  - wrong assumption concerning methods of deactivation (e.g. the system can be deactivated by stepping on a pedal)

- **Context: situation**
  - the driver first decides on the *wrong* action accelerating/breaking (unnecessarily hard/weak)
  - the driver is uncertain, whether accelerating or braking is the correct action: the driver accelerates (hard) and then brakes (hard), because at first they considered accelerating the better alternative, but re-assessed the situation later on
Definition
Complaints when solving take-over situation with regards to the vehicle operation

Mistake

Problems when solving take-over situation

Problems deactivating the system
- Deactivation (not immediately) successful, since the respective method was not applied correctly or was based on wrong assumptions concerning the methods of deactivation
- Examples:
  - driver does not hit the button long enough
  - driver hits the wrong button (e.g. in combination with a searching gesture)
  - driver hits only one instead of two buttons
  - driver does not hit several buttons simultaneously as required
  - steering action too weak
  - braking too weak
  - driver activates accelerator instead of brake
  - driver sets the indicator unintentionally, when this clearly happens in the context of a deactivation of the system
**DRIVER’S FACIAL EXPRESSION**

- **Visible emotions of the driver**
  - Nervous/tense
  - Surprised/worried
  - Hectic
  - Uncertain/confused
  - Others

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<tr>
<th></th>
<th>Faultless</th>
<th>Imprecisions</th>
<th>Driving Errors</th>
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<td>Longitudinal vehicle control</td>
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<td>unnecessary/ wrong use of indicator</td>
<td>missing/ too late use of indicator</td>
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<td>Vehicle operation</td>
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<td>imprecisions</td>
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<tr>
<td>Driver facial expression</td>
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<td>visible emotions</td>
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</tbody>
</table>

[1 2 3 4 5 6]
Definition
Apparent deviations of facial expression/body language/verbal utterances as compared to before the take-over situation

Uncertainty

<table>
<thead>
<tr>
<th>Apparent driver’s expression</th>
<th>Nervous/tense</th>
<th>Surprised/alarmed/startled</th>
<th>Hectic</th>
<th>Insecure/confused</th>
<th>Others</th>
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</thead>
<tbody>
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<td>• Driver shows signs of nervousness/tenseness (e.g. clenching their teeth, biting their lips, concentrated face, perhaps even verbal utterance)</td>
<td>• Driver seems to be surprised/worried (e.g. eyes wide open, open mouth, utterances such as “oh” or “oops”)</td>
<td>• Driver reacts to take-over in a hectic manner (e.g. throwing the object they were holding in their hand on the passenger seat)</td>
<td>• Driver shows signs of insecurity/confusion about was is happening or what they are supposed to do</td>
<td>• Other signs of emotion</td>
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