IMoST 2
Final Presentation
Work Package Experiments and Evaluation

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Goals of Experiments and Evaluation

- Provide data basis for human driver modelling

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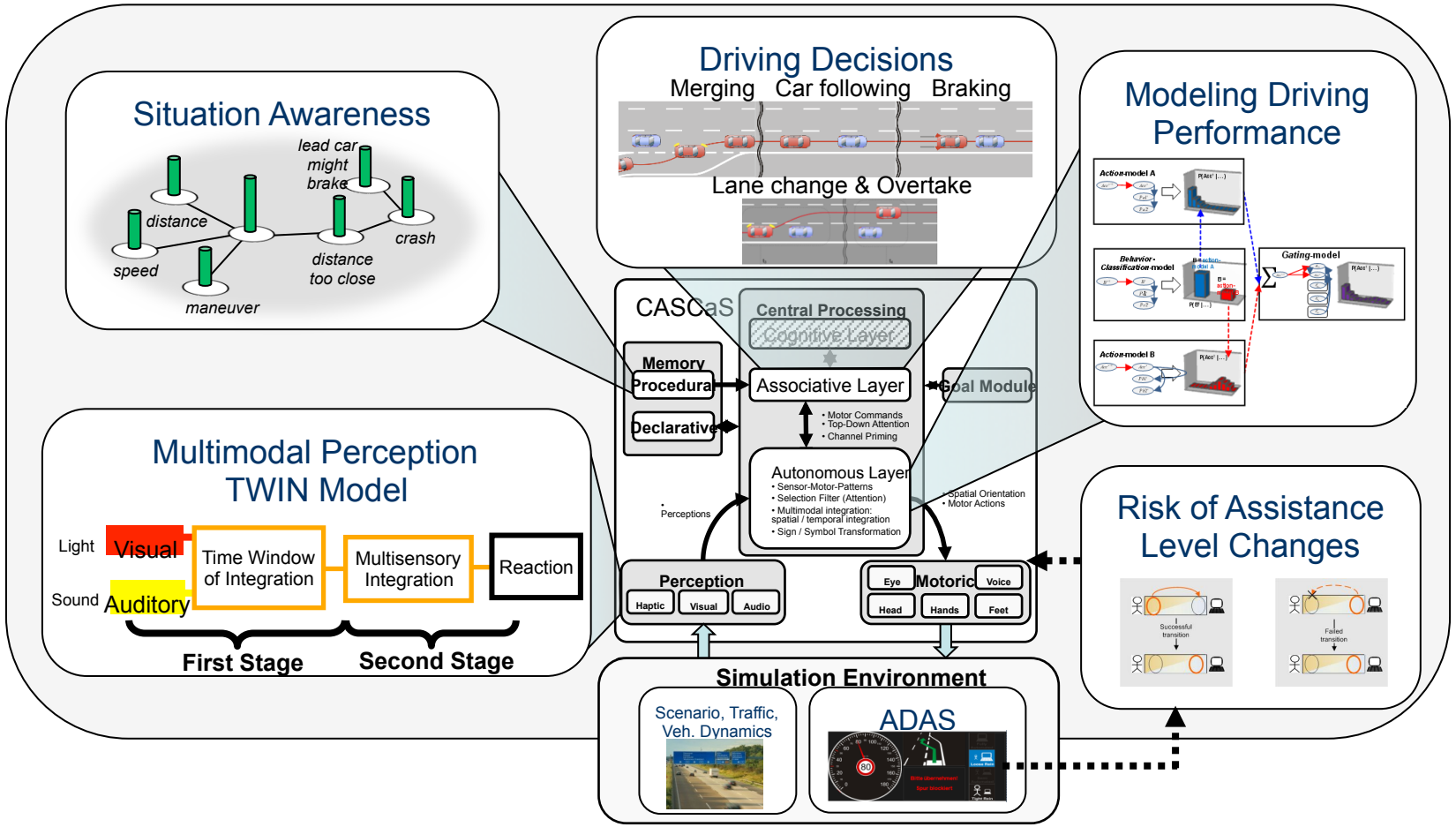

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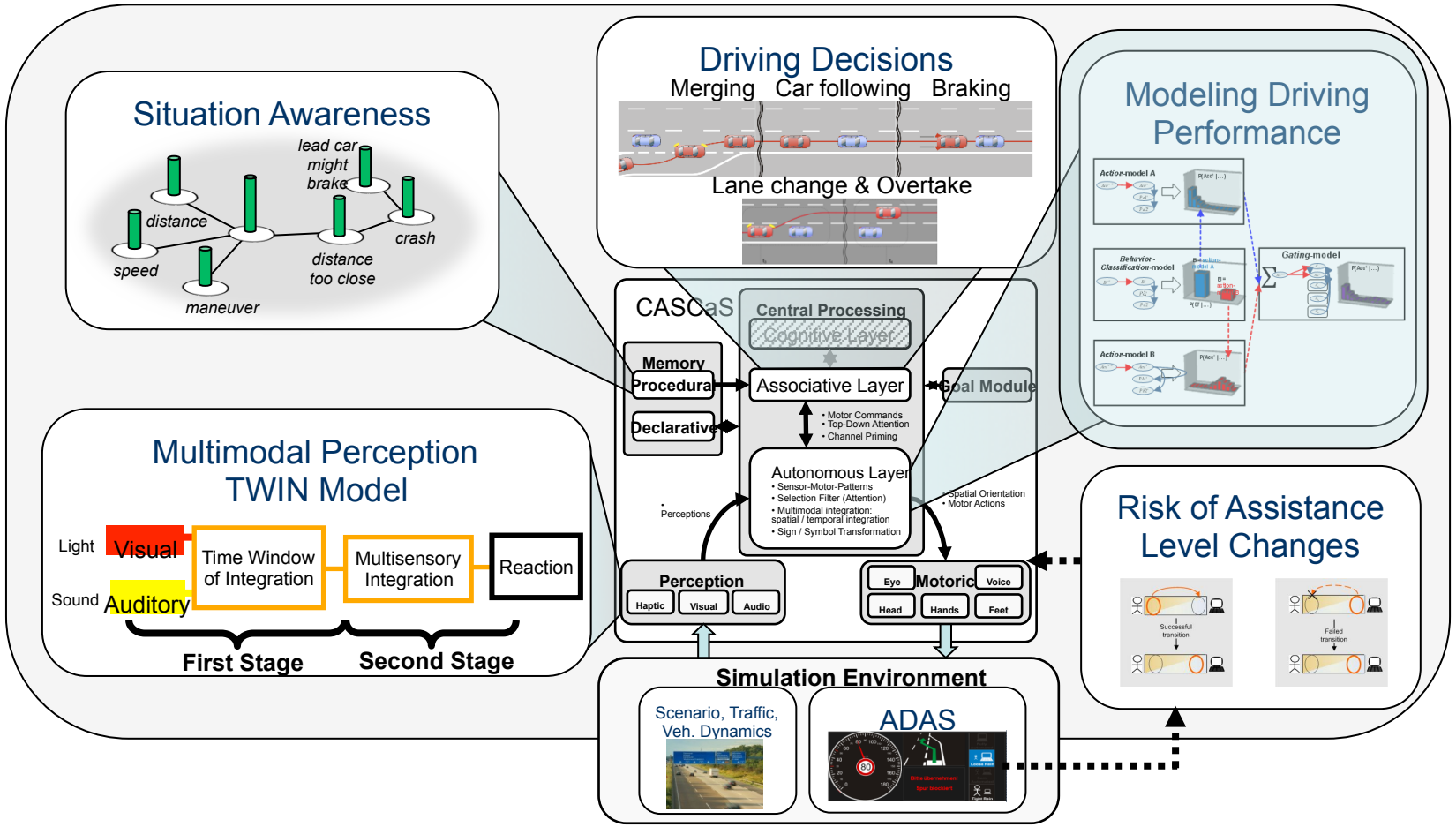

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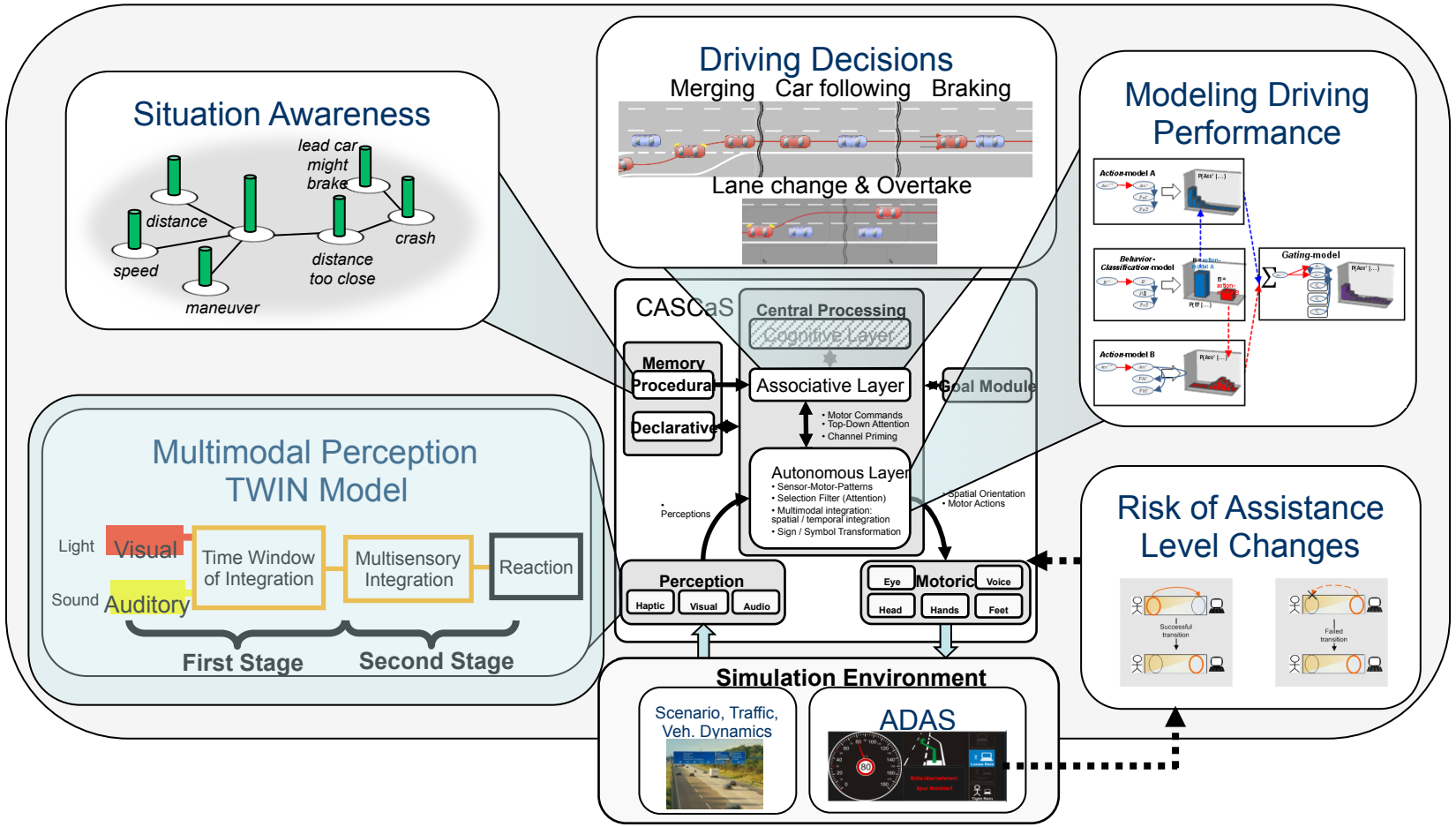

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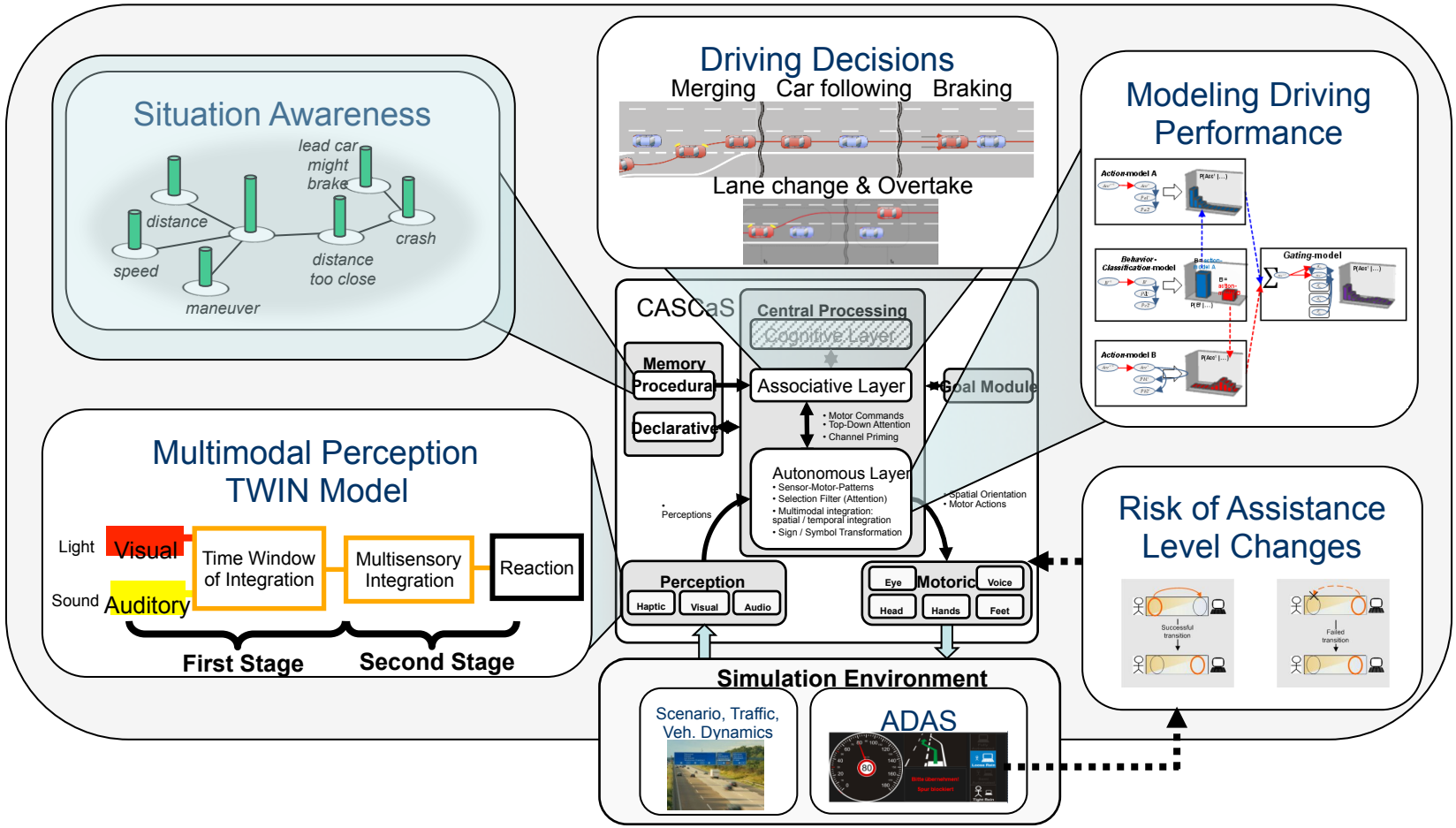

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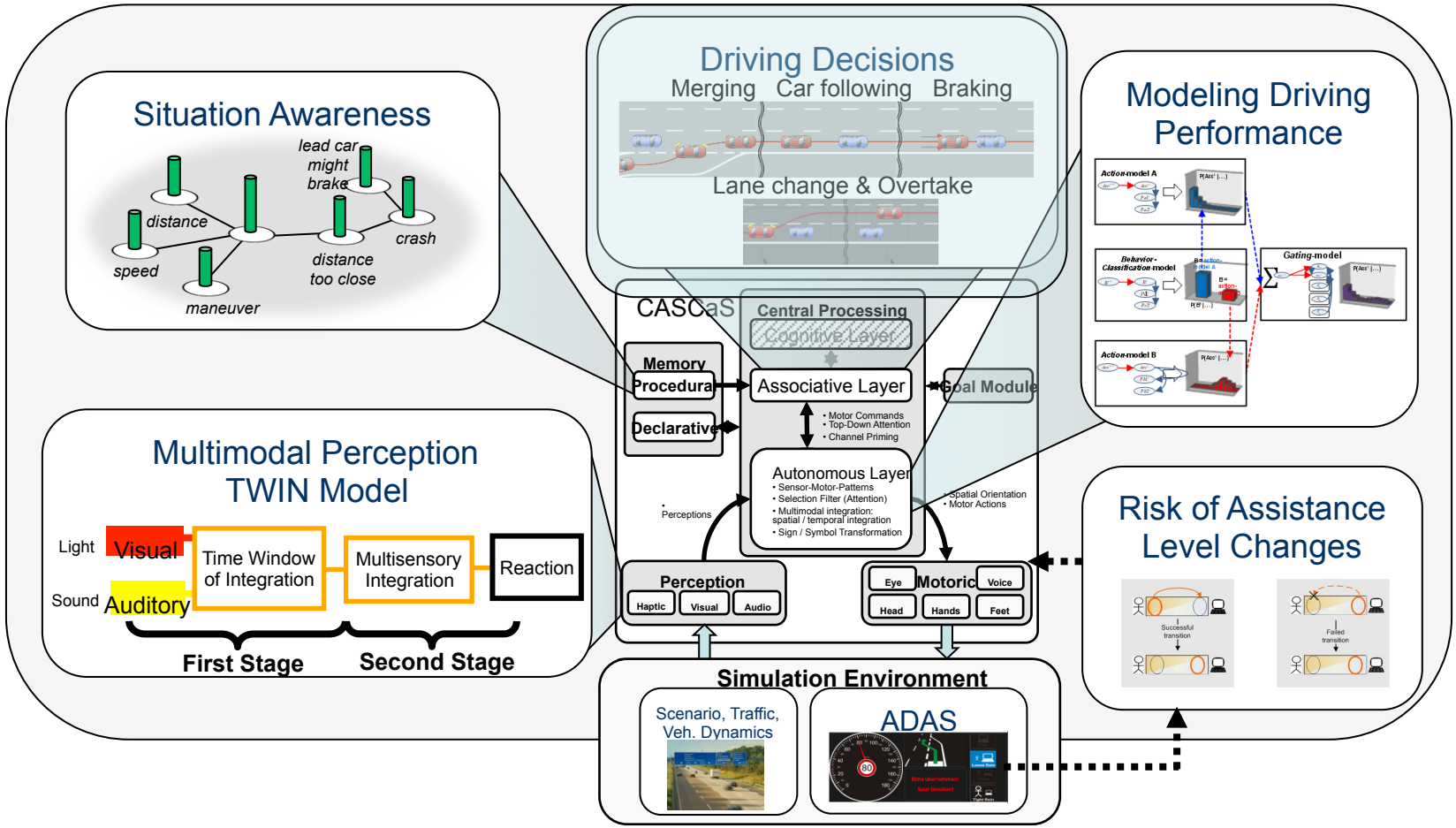

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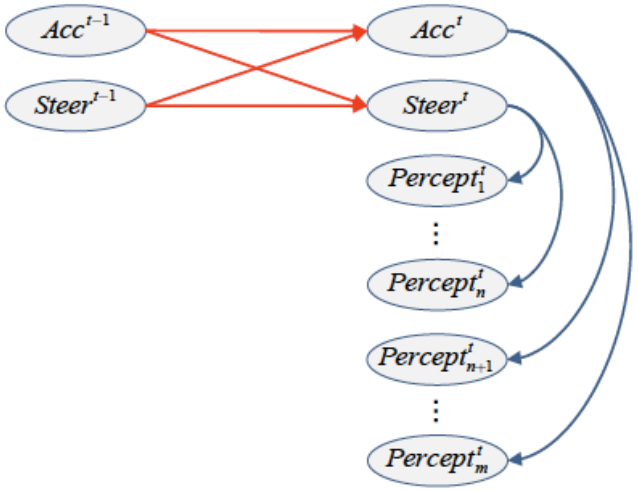
- Develop innovative driver assistance system as counterpart for modelling activities
- Empirical basis:
  - 8 experimental studies in driving simulators in Oldenburg and Braunschweig
  - Task analysis of driving tasks relevant for IMoST-2 scenarios

Driving Performance

Driving Performance

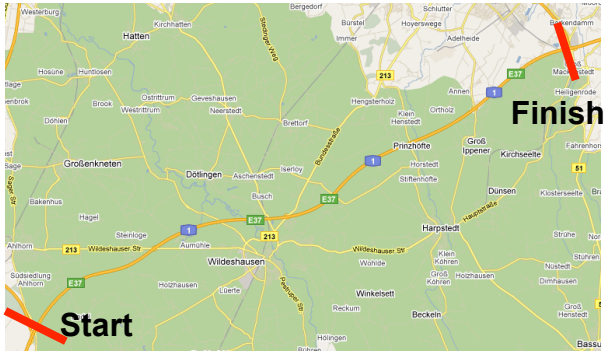
- Goal:
  - Develop a probabilistic model of human sensory-motor processes
  - Models the autonomous layer of driving behaviour



- Requirement:
  - Collect driving performance data under unrestricted driving conditions in relevant driving scenarios
  - When driving without and with assistance system (in assisted mode)

Driving Performance
Experimental Setup for one experiment

- 8 Participants
- Driving scenario
  - Appr. 40 km two-lane highway
  - Speed limit: 100 – 130 km/h
  - Behavior of other road users not controlled
  - Instructions: Obey traffic rules
- Experimental data obtained in one experiment:
  - > 500min of experimental data à 60 data samples per second
  - ~ 1,900,000 data samples for learning procedure



Multimodal Perception

Multimodal Perception

... perceive system signals quickly: "Can system outputs and information be **perceived** by the driver **quickly enough** to enable them to react appropriately (e.g. take over request from adaptive cruise control)?“

- Shall be achieved by multimodal HMI in modern driver assistance sytems

- How to combine signlas from different modalities to optimize perception of information?

Multimodal perception
TWIN Model Assumptions

- Basis for modeling multimodal perception: Time Window of Integration (TWIN) model
  - Multisensory integration of sensory information into a perceptual unit (“event”) occurs only if the peripheral sensory processes all terminate within a given temporal window

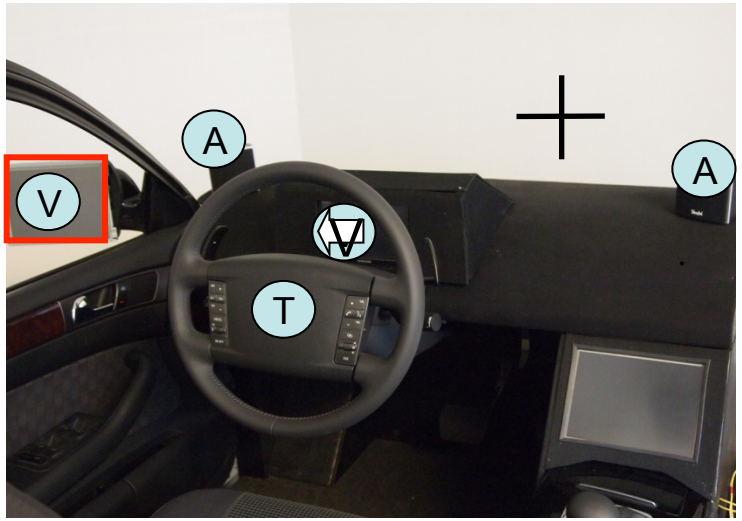
- Two-Stage process:
  - 1st Stage: Race of the stimuli from different modalities from the receptors to the different brain areas
  - 2nd Stage: Spatial integration of the stimuli

Multimodal Perception
Experiment

- How long does it take to detect visual signal?
  - Influence of temporal / spatial multimodal stimuli configuration on visual orientation reaction
  - Comparison of visual versus multimodal stimuli
- Using driving simulator environment
  - Characteristic of cues similar to ADAS
  - Spatial arrangement
- Reaction time measurement of eye movement

Multimodal Perception
Experiment - Material and Methods

- Fixation cross presented in an optical flow field
- Targets:
  - 2 visual cues (V)
- Non-targets:
  - 1 tactile cue,
  - 2 acoustic cues
- 4 Stimulus Onset Asynchronies (SOAs):
  - -50, 0, 50, 100msec
- Spatial conditions:
  - coincident
  - disparate



Multimodal Perception
Experiment - Material and Methods

- Task of the Participants:
  "Move your eyes from the fixation point to the visual target stimulus as fast and as accurately as possible while ignoring the non-target (acoustical or tactile) stimulus."

Results
TWIN-Model and empirical Data

- Major trends:
  - RT with multimodal stimulus always faster than RT after visual stimulus
  - RT fastest when acoustic signal precedes visual target stimulus by 50 msec
  - RT faster when location coincident compared to disparate location

Situation Awareness

Situation Awareness

... understand what the system is doing: "Does the human-machine interaction of the system **prevent the driver from losing situational awareness** (e.g. keeping the driver in the loop, providing a consistent warning strategy)?"
Situation Awareness (Dr. Martin Baumann)

- Precondition for safe driving:
  - Coherent and adequate mental representation of the traffic situation
  - = situation awareness: „Knowing what is going on around you" (Endsley, 2000)
- Goal for IMoST-2
  - Further develop CASCaS as an engineering tool in terms of situation representation
    - Inspired by comprehension based theory of situation awareness (Baumann & Krems, 2009)

Situation Awareness
Requirements for driver model

- According to Baumann & Krems (2009), Durso et al., (2007)
  - Construction of situation representation is based on sequential integration of perceived information with knowledge from LTM
- Representation of task knowledge is highly important
  - GMTA analyses of driving tasks were conducted as basis for knowledge definition of driver model
- Extension of object representation and spatial representation
  - more explicit situation representation compared to IMoST-1
    - Objects with features (position, speed, …)
  - Ego-centric spatial representation (Harrison & Schunn, 2003)
  - Step-wise construction of situation representation for representation levels

Situation Awareness
Experiment on situation representation

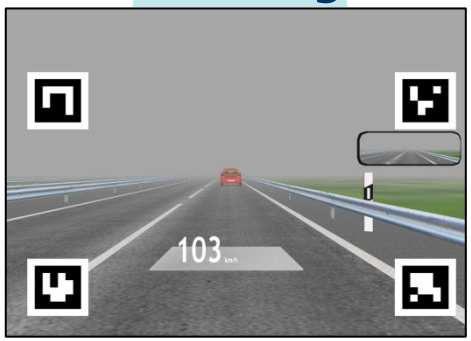
- Research focus
  - Representation of spatial situation
  - Freeze-method in a driving context

- Research questions
  - How well do people remember other cars on a motorway?
  - Does their gaze behavior indicate the state of their knowledge about other cars?

Situation Awareness
Experiment on situation representation

- Scenario
  - 2-lane motorway
  - „Maintain speed of 100 km/h. Overtake if necessary“
  - Sudden freeze of simulation during lane change
- Factors
  - Levels of assistance
  - Target lane

Driving



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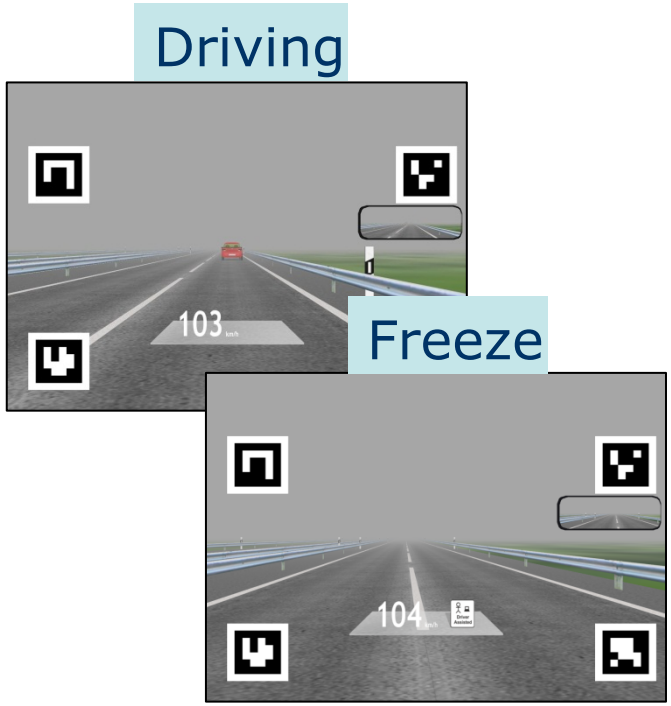

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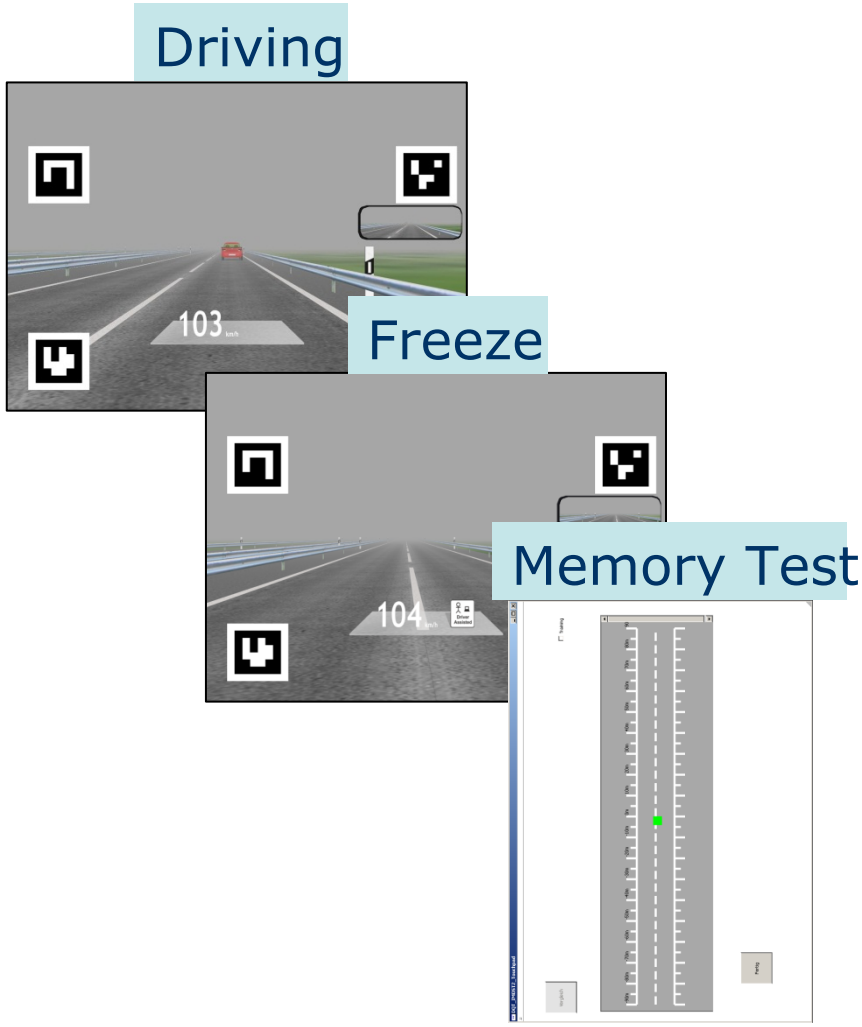
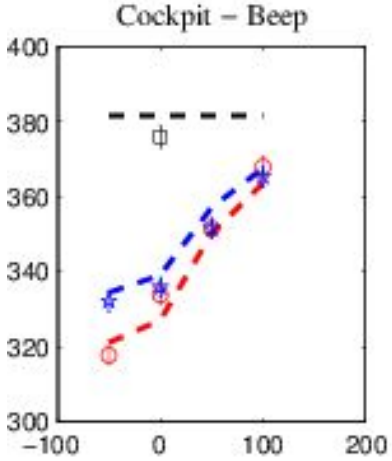


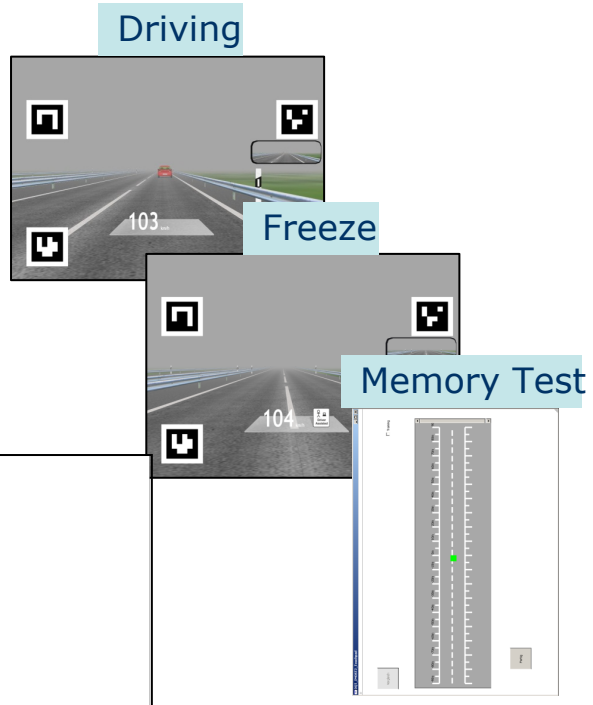
Situation Awareness
Experiment on situation representation

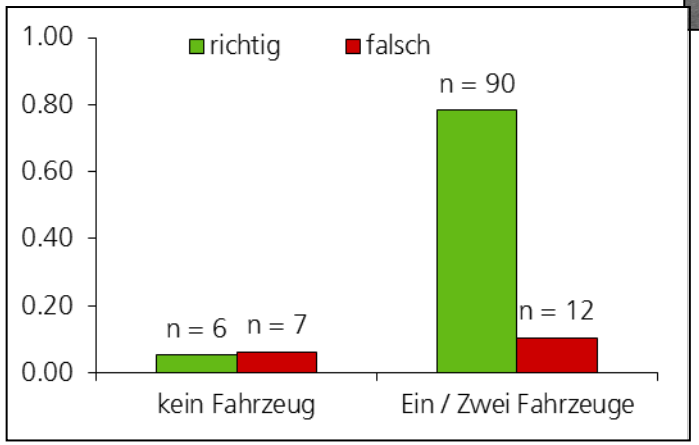
- Availability of surrounding vehicles in memory test depends highly on relevance of vehicle for performing manoeuver
- If a vehicle is present at positions left front, right front and left behind it is recalled with high probability
- Vehicles right behind seem to be neglected

Experiments and Evaluation Summary

- Broad empirical basis on relevant phenomena established







Experiments and Evaluation Summary

- Broad empirical basis on relevant phenomena established
  - But still gaps
- Empirical investigation of underlying psychological processes needs to be continued
  - General process of multimodal perception
  - Spatial representation of traffic situation
  - Construction of situation representation
- Integration into CASCaS architecture and driver model

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OFFIS INSTITUT FÜR INFORMATIK

DLR Deutsches Zentrum für Luft- und Raumfahrt e.V. in der Helmholtz-Gemeinschaft

IMoST Integrated Modelling for Safe Transportation

Thanks for your attention!