Anticipating the individual User

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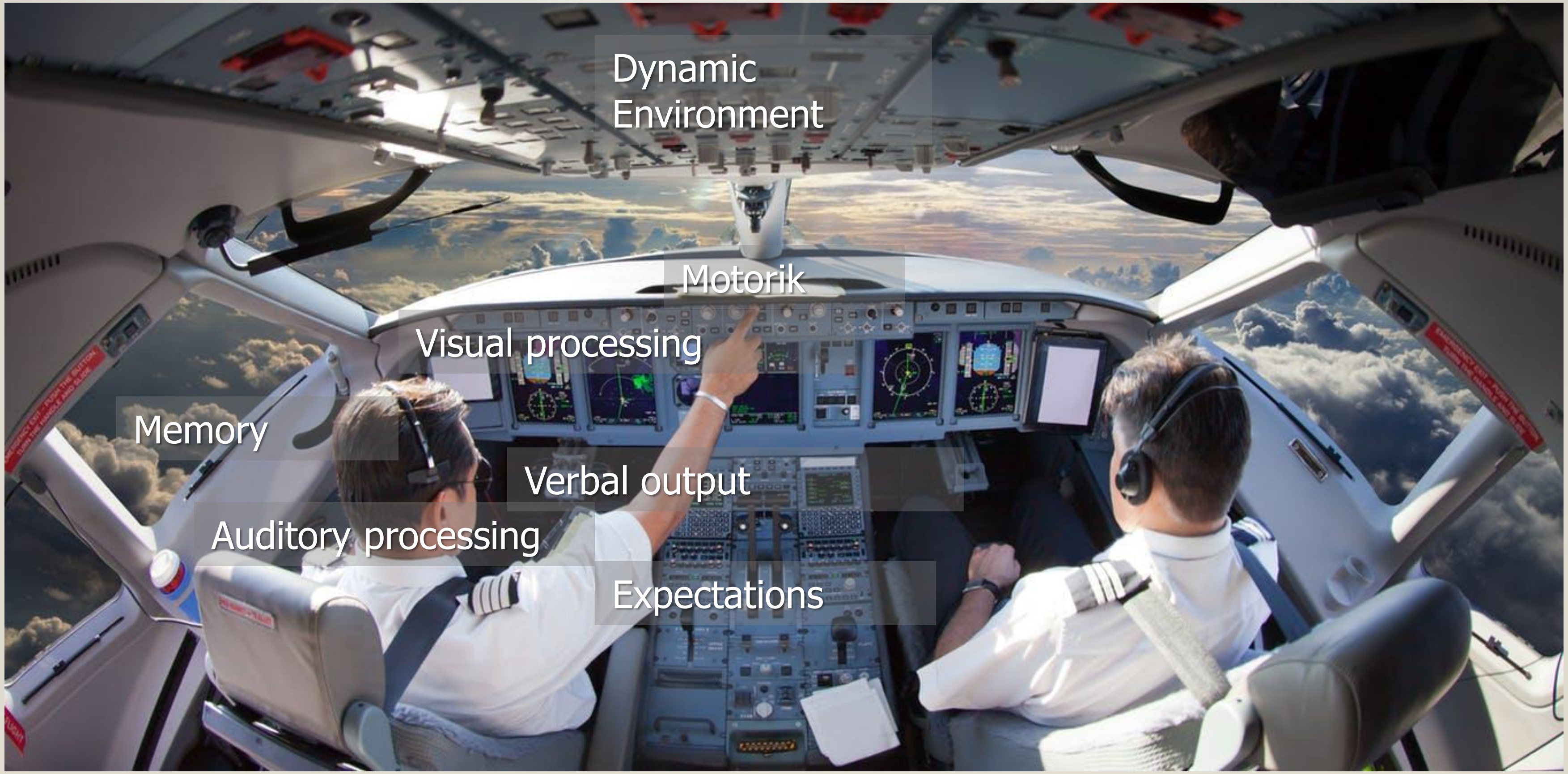
AUTOMATION VS. AUTONOMY

- […] **automation** as technology that requires human intervention or control and **autonomy** as technology capable of working alongside humans as teammates, carrying out the essential taskwork and teamwork functions of a human teammate (McNeese et al., 2016).
- Autonomy capitalizes on technology's ability to make intelligent decisions and adapt to **task**, **situation**, and **context**, […] (Cox, 2013).

McNeese, N.J., Demir, M., Cooke, N.J., & Myers, C.W. (2018). Teaming With a Synthetic Teammate: Insights into Human-Autonomy Teaming. Human factors, 60 2, 262-273 .

COMPLEX HUMAN MACHINE INTERACTION

The largest proportion of pilot errors is due to incorrect perception (70.3%) and understanding of the situation (20.3%) (Jones & Endsley, 1996).



ANTICIPATING THE INDIVIDUAL USER

- Trace User behavior, in the **task context**, in the **specific situation** and in **the context**.
- Is the user in the cognitive state predicted by the model?
  - What information has been perceived and processed?
  - Is the state of Situation awareness accordingly?
  - Do we anticipate a surprise reaction of the operator?
  - Can the model explain the behavior witnessed?
- When the cause of diverging behavior is known, assistance can better and quicker address the operator and the problem.

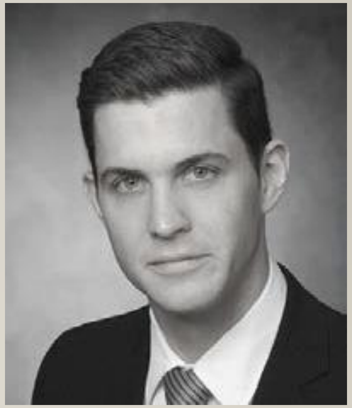
Cognitive Models for intelligent interfaces in the Cockpit

KModyS
TU Berlin

Further cooperationspartners:

Thorsten Zander
Laurenz Kroll
Christoph Vernaleken
Inge Wenzel

AIRBUS
Classic Cockpit Operations



Oliver Klaproth

zander laboratories

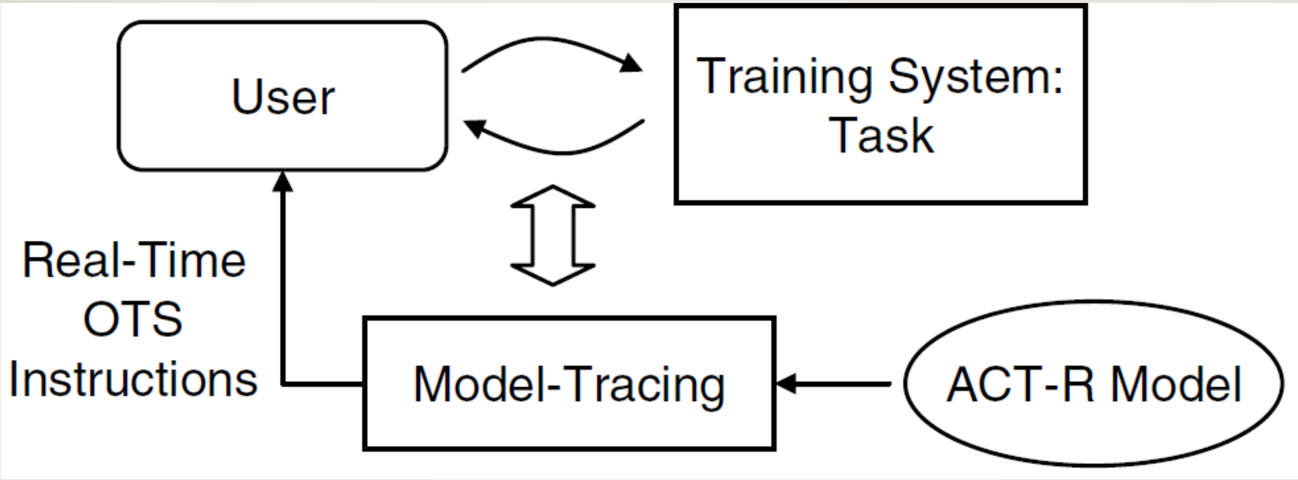
AIRBUS CR&T

Klaproth, O., W., Halbrügge, M. & Russwinkel N. (2019). ACT-R model for cognitive assistance in handling flight deck alerts. In Proceedings of the 17th International Conference on Cognitive Modelling (ICCM 2019), Montreal, Canada.

Kroll, L. R., Klaproth, O., Vernaleken, V., Wetzel, I., Gaertner J., Russwinkel, N., & Zander T.O. (2018). Towards a Neuroadaptive Cockpit: First Results. 3rd International Mobile Brain/Body Imaging Conference. Berlin Germany.

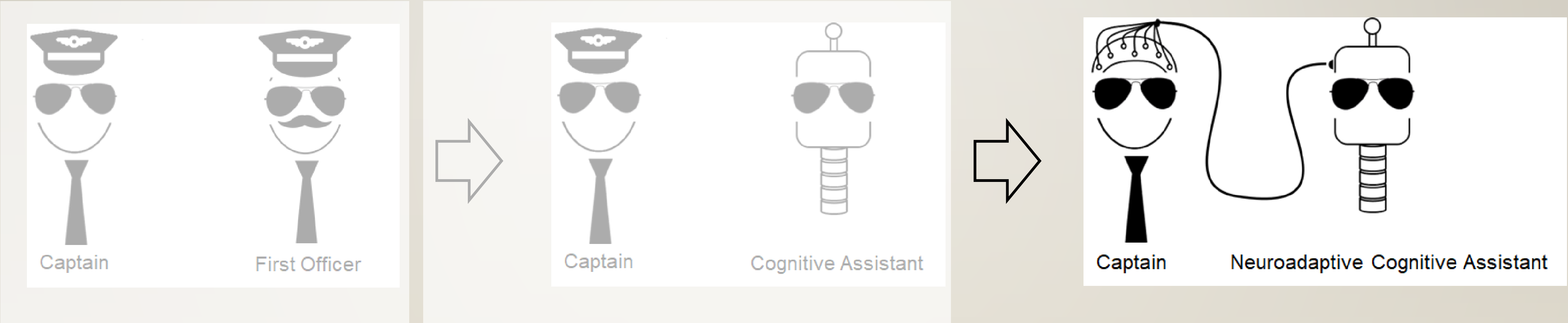
MODEL-TRACING

The cognitive model should keep track of the learning process and the various cognitive states in real time, and inform the training system to deliver training material in ways that facilitate the effectiveness of training.



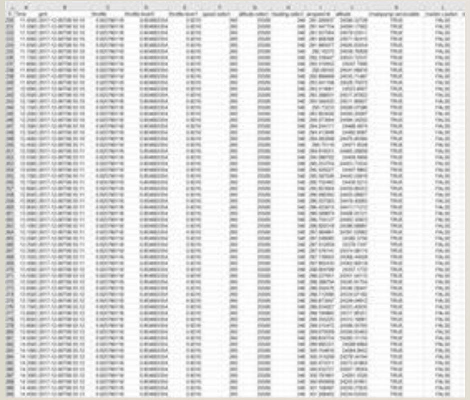
Fu, W.-T., Bothell, D., Douglass, S., Haimson, C., Sohn, M.-H., & Anderson, J. (2006). Toward a real-time model-based training system. *Interacting with Computers, 18*(6), 1215–1241.

NEUROADAPTIVE MODEL



NEUROADAPTIVE MODEL

Simulator



Aircraft parameters

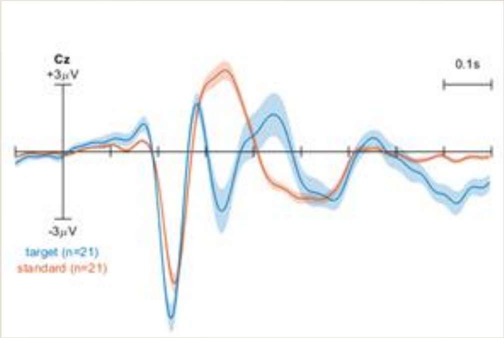
Cognitive model

Hierarchical Task Analysis

Layer 1	Layer 2	Layer 3	Layer 4	Layer 5	Layer 6	Layer 7
Fly scenario						
	0. Manage speed during climb and cruise					
		0.1. Monitor selected speed				
		0.2. Monitor ground speed				
		0.3. Monitor altitude				
		0.4. Adjust thrust lever accordingly				
	1. Handle fuel pump alert					
		1.1. Hear alert				
		1.2. Read warning				
		1.3. Press master caution/master warning				
		1.4. Go through pump failure checklist				
			1.4.1. Right main fuel pump OFF			
			1.4.2. X-Feed Valve ON			
			1.4.3. Gravity X-Flow AS REQ			
		1.5. Validate by checking fuel display				
	2. Handle TCAS					
		2.1. Hear Callout "Traffic Traffic"				
		2.2. Prepare for manual maneuver				
			2.2.1. Grab throttle			
			2.2.2. Grab Sidestick			
		2.3. Spot orange dot on Nav/Minifaw				
		2.4. See dot turn white				
		2.5. Take hands off of sidestick and throttle				
	3. Handle engine failure					
		3.1. Hear warning				
		3.2. Press master caution/master warning				
		3.3. Go through engine fire checklist				
			3.3.1. Right thrust lever to IDLE			
			3.3.2. Right engine master switch to OFF			
			3.3.3. Engine fire push button to off			
				3.3.3.1. Open switch guard		
				3.3.3.2. PRESS button		
			3.3.4. Wait for 10 seconds			
			3.3.5. DISCHARGE fire extinguishing agent #1			
			3.3.6. Wait for 30 seconds			
			3.3.7. DISCHARGE fire extinguishing agent #2			
		3.4. Go through follow-up checklist opens				
			3.4.1. Rudder trim			
			3.4.2. Engine mode to ignition			
			3.4.3. Open crossfeed valve (overhead)			
			3.4.4. Shut down right generator			
			3.4.5. TCAS Mode change			
	4. Handle fuel imbalance					
		4.1. Notice fuel imbalance early on				
		4.2. Wait for warning				

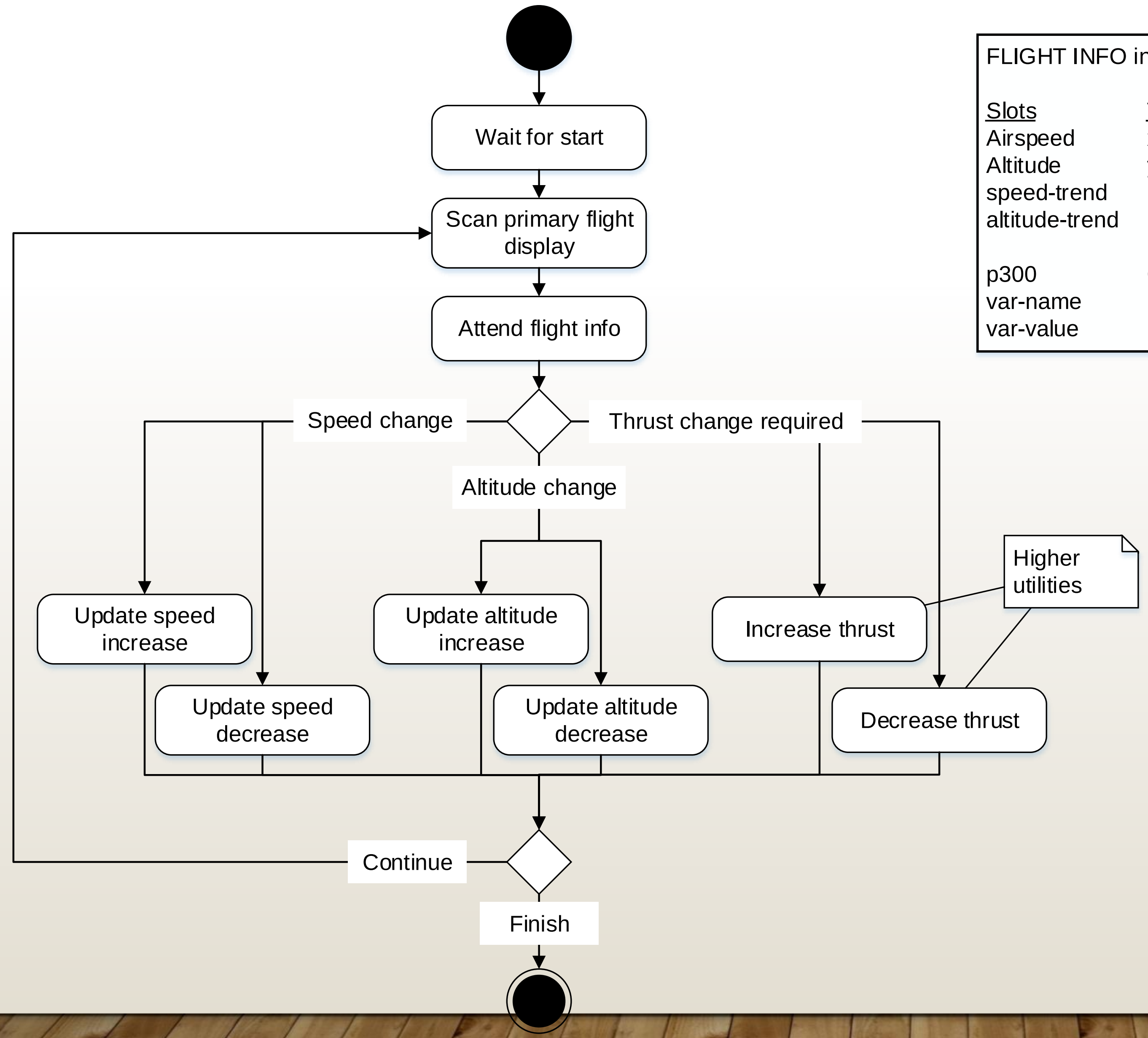
Task analysis

Pilot



EEG data

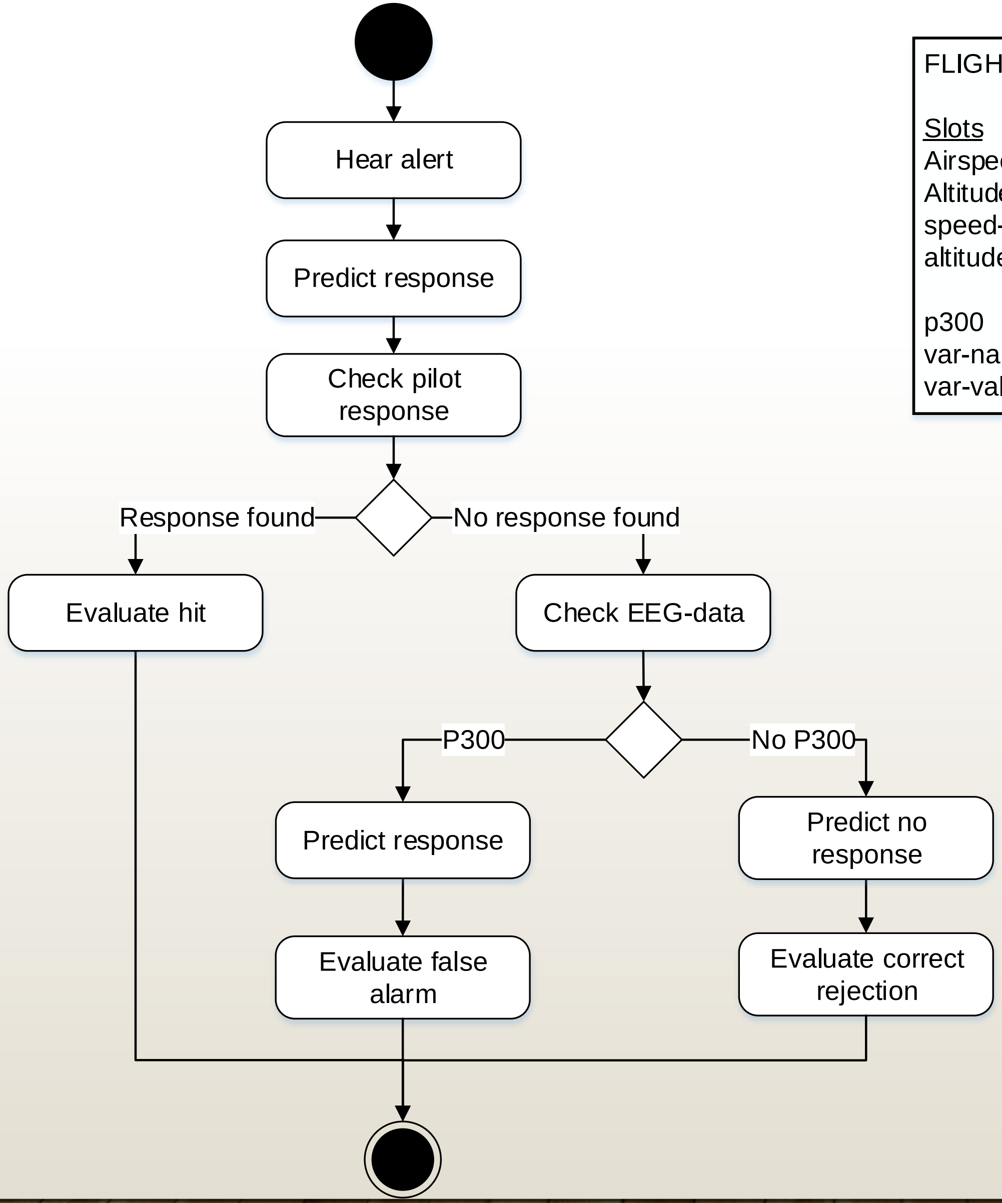
COGNITIVE PILOT MODEL



FLIGHT INFO in imaginal buffer

Slots	Values
Airspeed	x knots
Altitude	y feet
speed-trend	incr./decr.
altitude-trend	incr./decr.
p300	0/1
var-name	response (where)
var-value	response (what)

COGNITIVE PILOT MODEL



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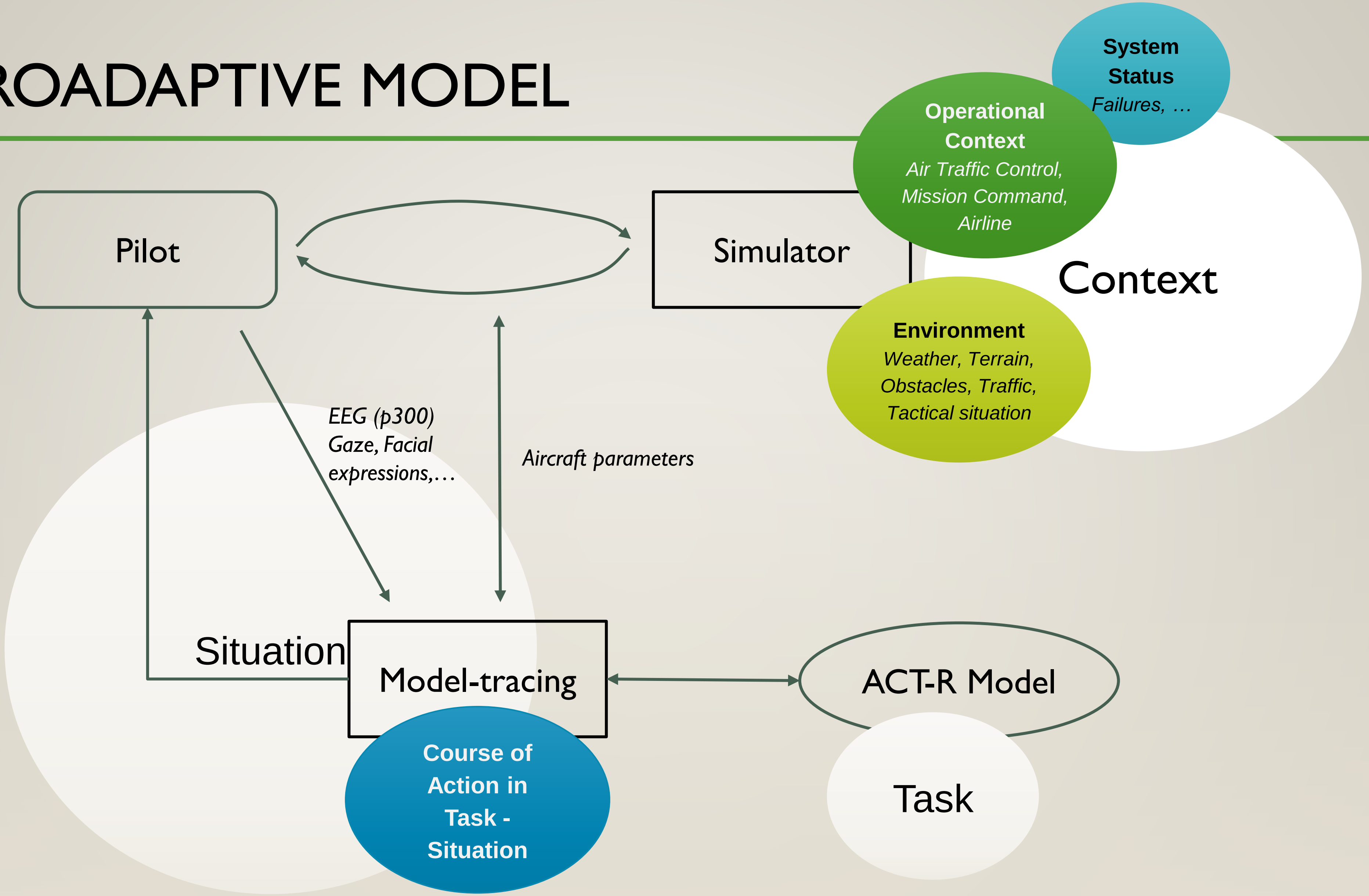
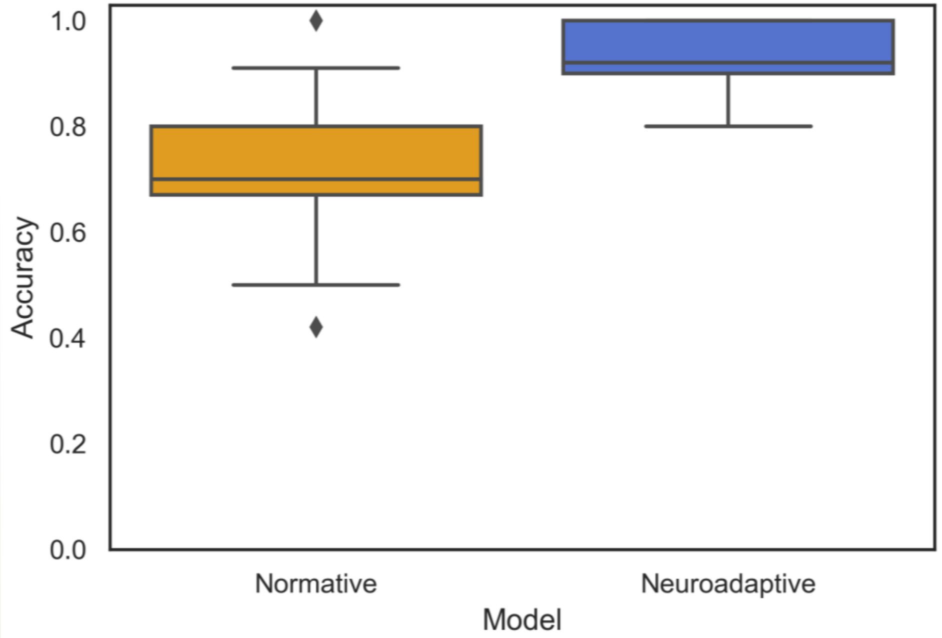
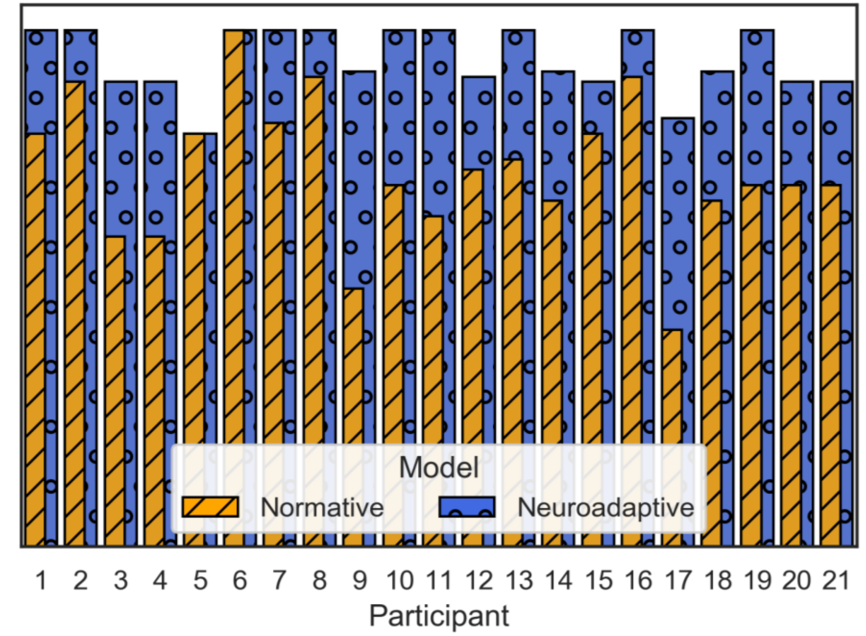
NEUROADAPTIVE MODEL



Adapted from Fu, W.-T., Bothell, D., Douglass, S., Haimson, C., Sohn, M.-H., & Anderson, J. (2006). Toward a real-time model-based training system. *Interacting with Computers, 18*(6), 1215–1241.

MODEL RESULTS





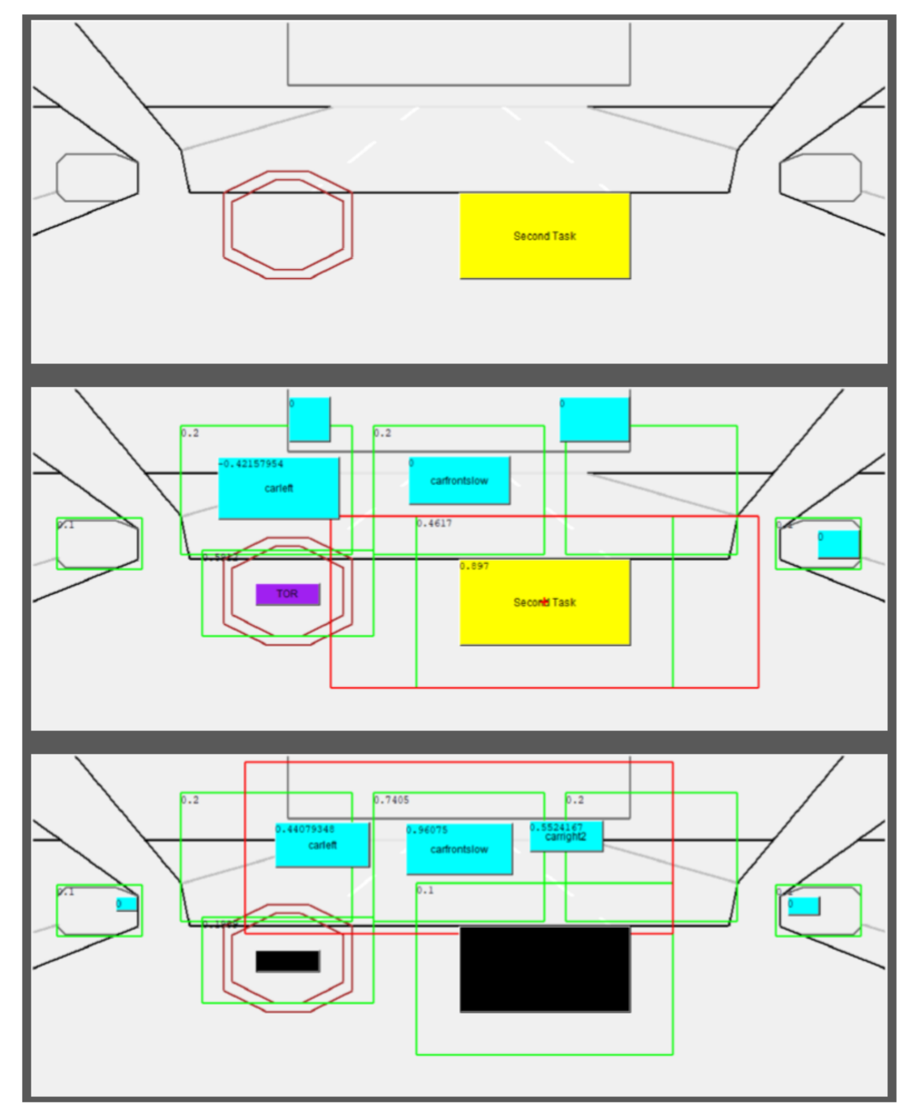
$Mdn_{Norm.}$ = 0.73 (IQR = 0.8 - 0.67)
$Mdn_{Neuro.}$ = 0.92 (IQR = 1.0 - 0.9)

A COGNITIVE MODEL FOR THE TAKEOVER IN HIGHLY AUTOMATED DRIVING

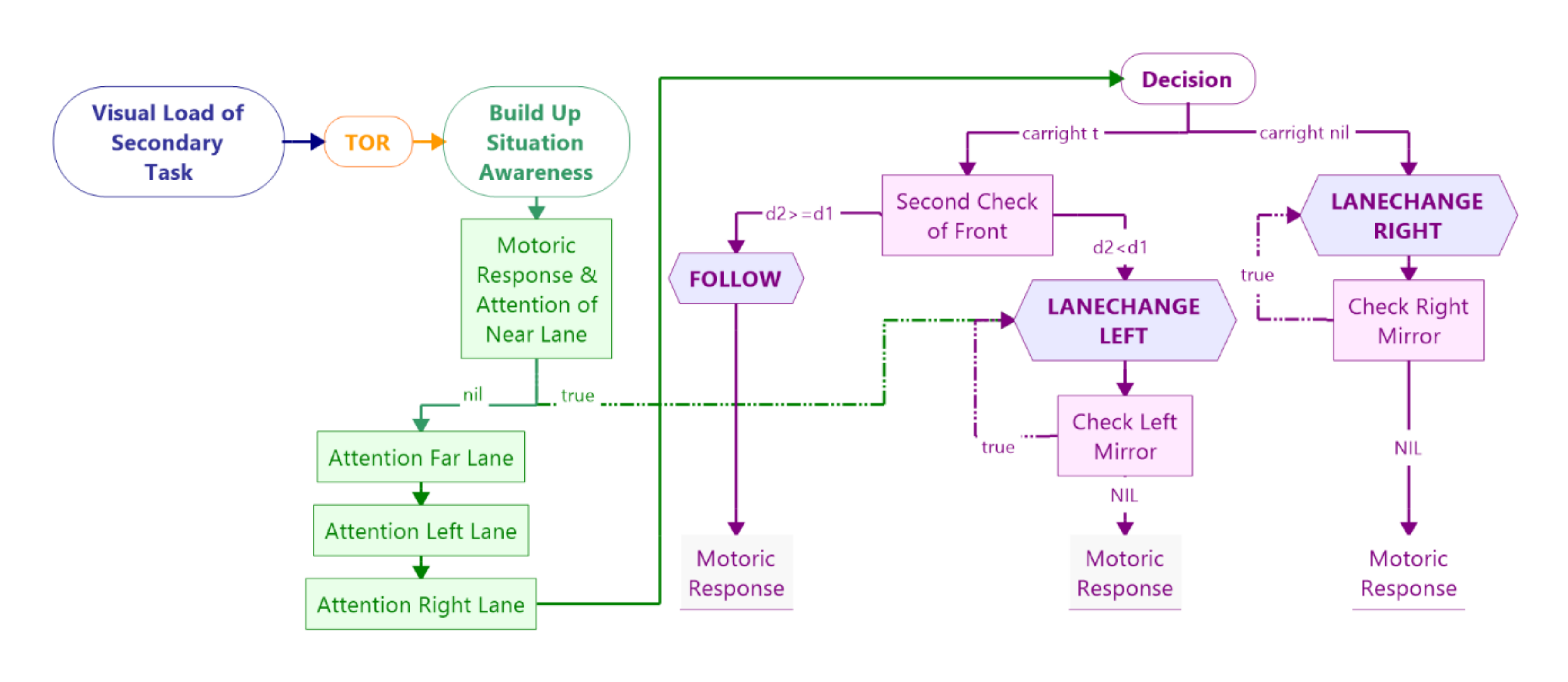
- Marlene Scharfe
- TU Berlin & Robert Bosch GmbH

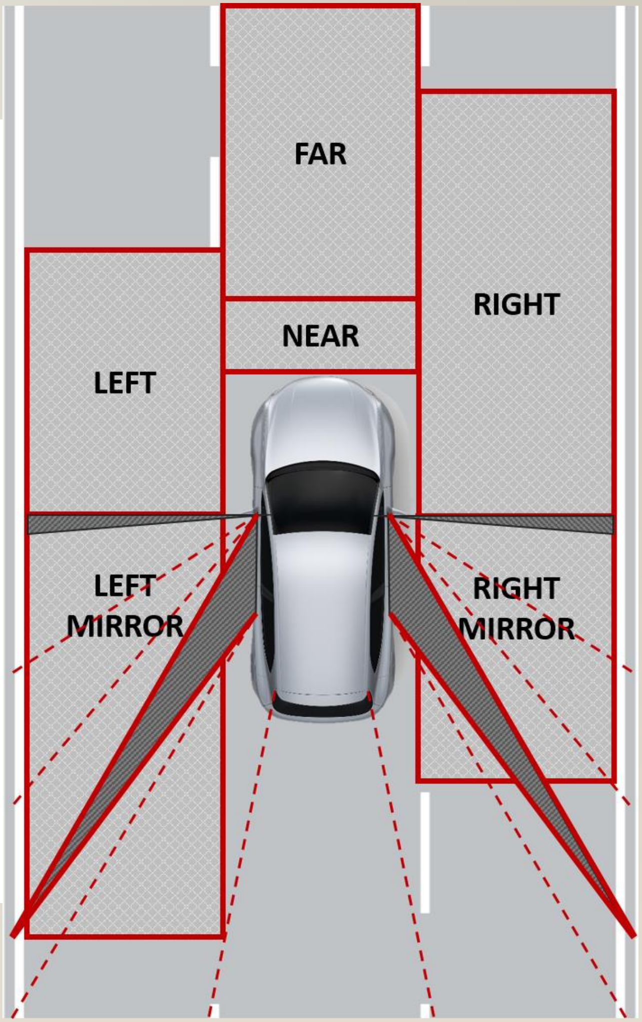
AIMS

1. Anticipating cognitive processes during take over procedure
2. Detect individual differences e.g. by subjectively perceived complexity
3. Interaction with a dynamic environment (**context**)
4. AOIs for visual perception based on the SEEV-theory (**situation**),
5. Predict behavior e.g. duration of take-over or quality of decision (**task**)



Cognitive Model STRUCTURE

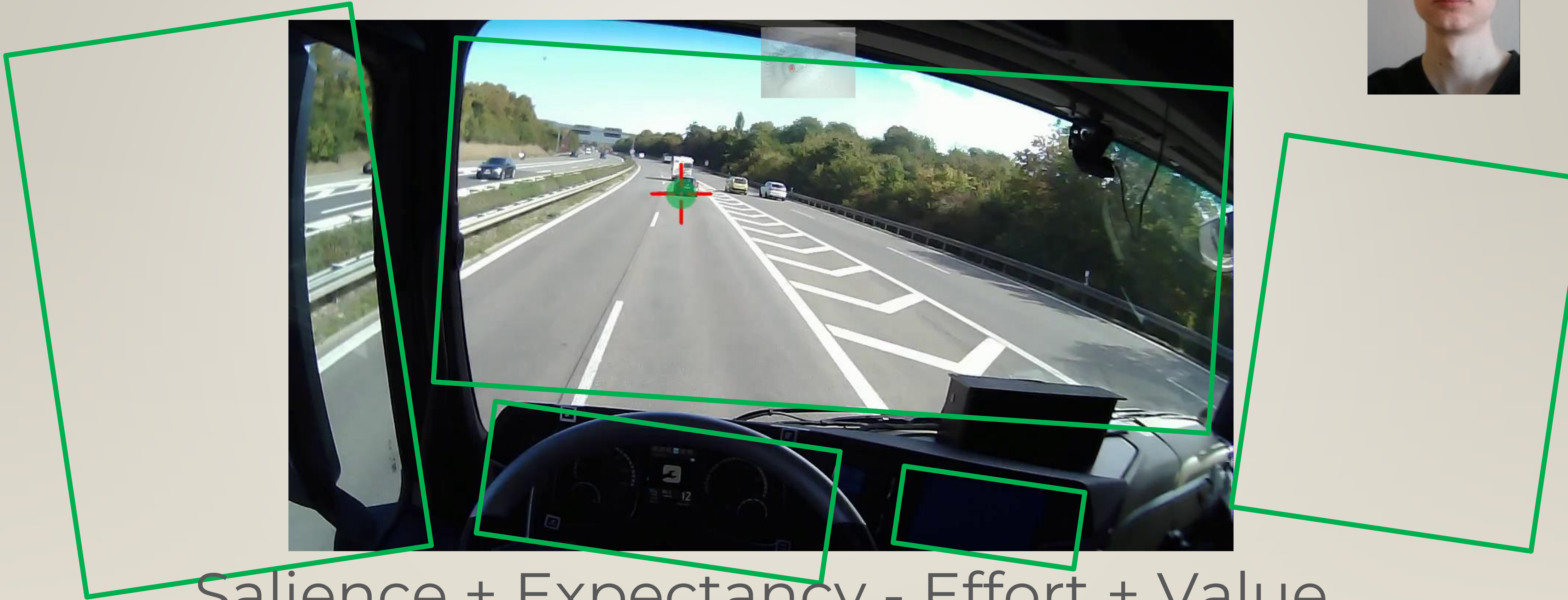




Scharfe, M., & Russwinkel, N. (2019). Towards a Cognitive Model of the Takeover in Highly Automated Driving for the Improvement of Human Machine Interaction. In Proceedings of the 17th International Conference on Cognitive Modelling, Montreal, Canada.

Scharfe, M., & Russwinkel, N. (2019). A Cognitive Model for Understanding the Takeover in Highly Automated Driving Depending on the Objective Complexity of Non-Driving Related Tasks and the Traffic Environment. In 41st Annual Meeting of the Cognitive Science Society Montreal, Canada.

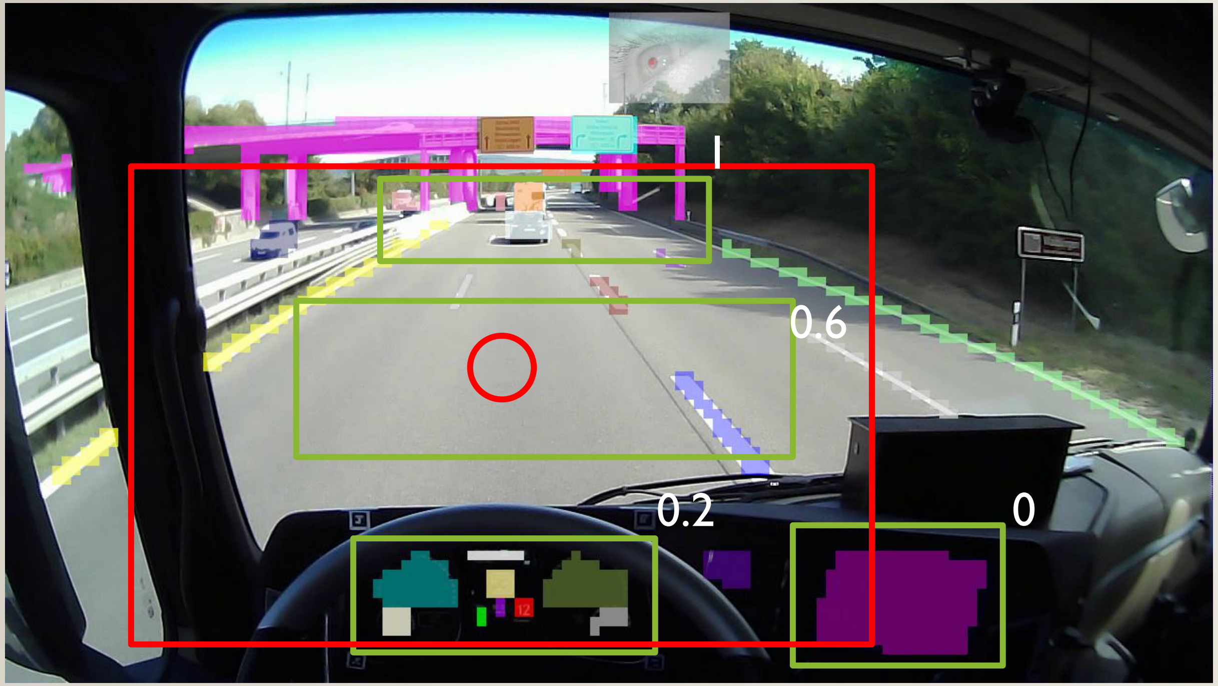
SEEV model of visual attention: Sebastian Wiese



Salience + Expectancy - Effort + Value

Wickens, C. D., 2015. *Noticing events in the visual workplace: The SEEV and NSEEV models.* In: R. R. Hoffman, et al. eds. Part VI - Perception and Domains of Work and Professional Practice. Cambridge: Cambridge University Press, pp. 749-768.

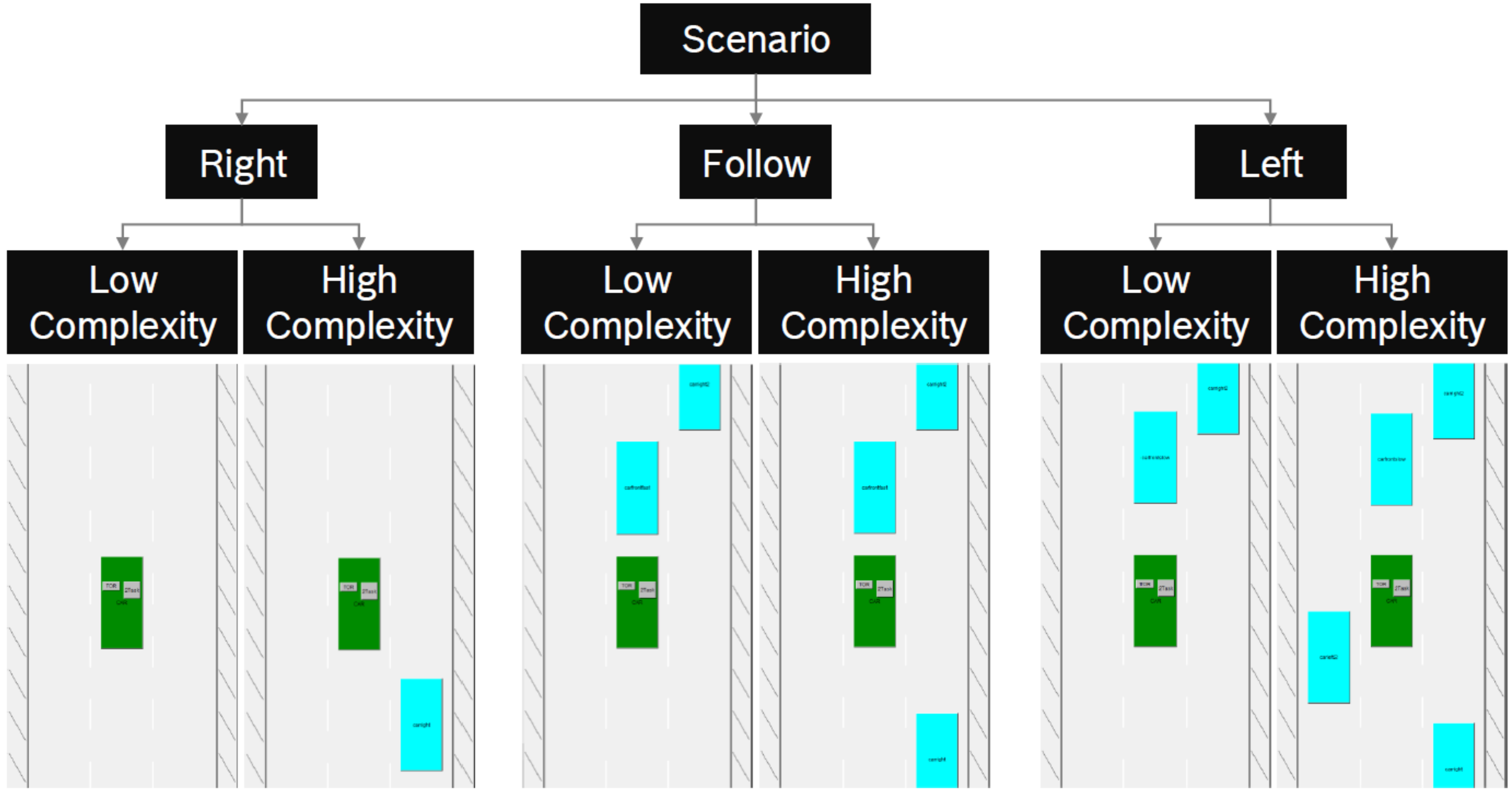
guiding visual attention

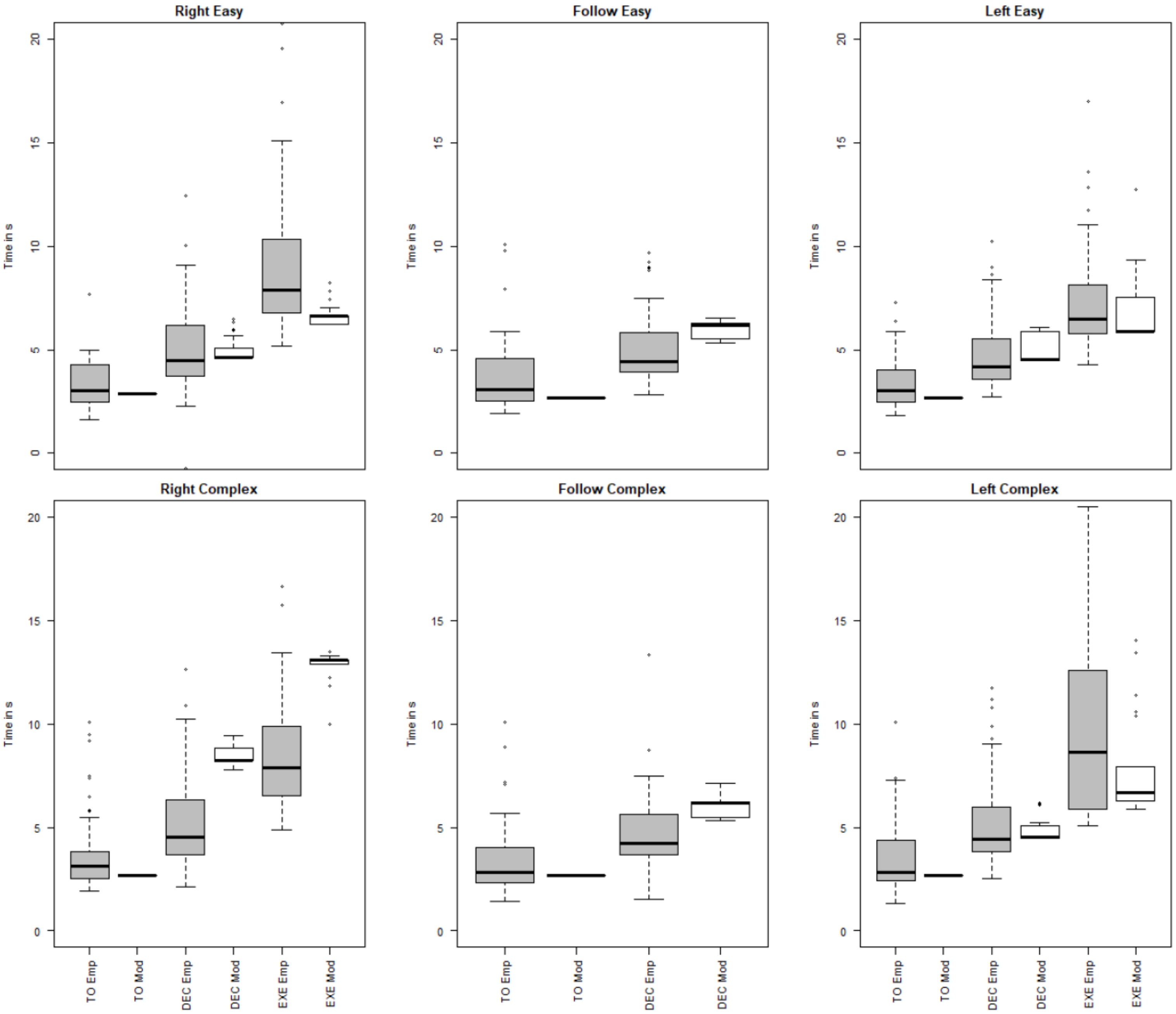


Salience + Relevance - Effort – Inhibition of Return

update relevance, inhibition → calculate guidance value → guidance value race

Lotz, A., Wiese, S. & Russwinkel, N. (2019). SEEV-VM: ACT-R Visual Module based on SEEV theory. In Proceedings of the 17th International Conference on Cognitive Modelling (ICCM 2019), Montreal, Canada.


Scenario
Right
Follow
Left
Low Complexity
High Complexity
Low Complexity
High Complexity
Low Complexity
High Complexity


Right Easy
Follow Easy
Left Easy
Right Complex
Follow Complex
Left Complex
Time in s
TO Emp
TO Mod
DEC Emp
DEC Mod
EXE Emp
EXE Mod

FAZIT

- For better collaboration between technical systems and the user an understanding of **Task**, **Situation** and **Context** is needed.
- The model or cognitive system does not need to capture all details but the most relevant aspects.
  - The individual trace of events and attention allocation (e.g. information or transitions missed)
  - Individual differences of information processing (e.g. spatial cognition, working memory capacity, subjective complexity…)
- High relevance to understand why the operator's behavior differs from expected behavior.

- For such approaches we need to combine model approaches with physiological methods and share information from the processing systems.

THANK YOU!

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