A Cognitive Model for the Takeover Task in Complex Environments for Highly Automated Driving.

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INTRODUCTION

This study aims at refining a cognitive model for the takeover in highly automated driving. It is able to interact with different traffic scenarios and represent human cognition to build up situation awareness [1]. Model predictions are compared to empirical data. The aim is to answer the following questions:

Is the cognitive model able to interact with environments of different objective complexity?

Do model predictions and empirical data significantly correlate?

WHY

- Driver will still play an important role in future levels of automated driving
- Few cognitive models for the driving task [2]
- Understanding of **cognition** and building of **situation awareness** [1] after out-of-the-loop behavior is important to develop useful **cognitive assistant systems**

WHAT

→ Development of a cognitive model using ACT-R [3]

→ Depiction of the impact of objective complexity on the takeover from a non-driving related task until an action execution in highly automated driving

→ Prediction of takeover patterns in different traffic situations to build up situation awareness

HOW

Productions of the cognitive model in ACT-R

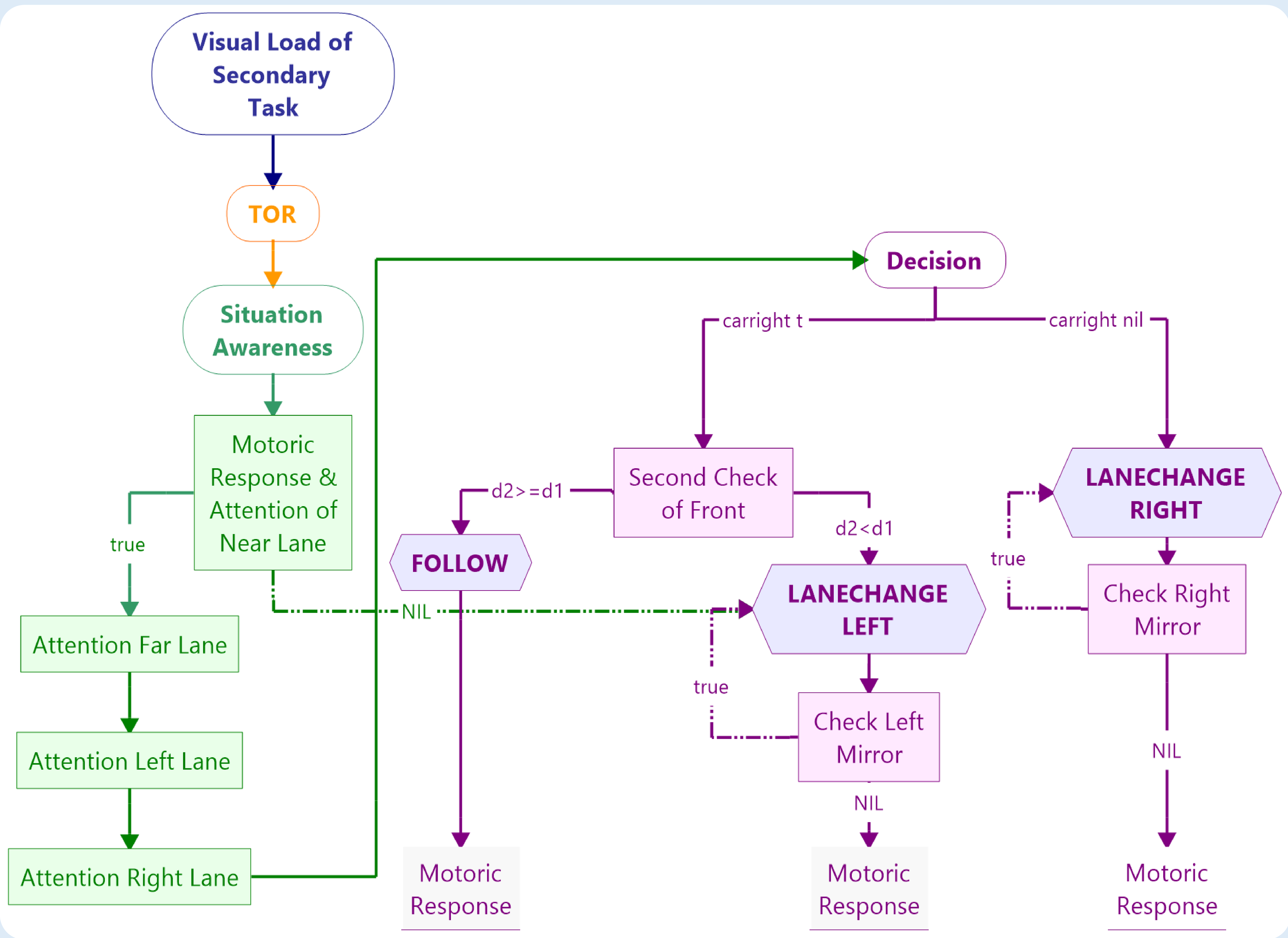

Figure 1: Schematic Representation of Cognitive Processes in the Model (Source: Scharfe, & Russwinkel, 2019).

Results:

Compared to time courses in empirical data of a real traffic study (N = 14), model predictions show significant (bivariate pearson) correlations to human data ($r(2)$ = .95, p =.05).

With an increase of the amount of objects in the traffic environment, the reaction time to execute a maneuver increases.

The model is run through 17 scenarios, varying in complexity (0 - 5 vehicles).

The outcome shows a significant rise in time until the action decision was made with a β-coefficient of 0.04 ($\beta = .04, p < .05$).

OUTLOOK

- Include differentiations between different drivers
- Include more objects (apart from relevant vehicles) that play an important role during the takeover

CONCLUSION

The model is able to:

- predict global cognitive patterns,
- adapt to different driving environments and
- perform cognitive patterns accordingly

[1] Endsley, M. R. (1995). Toward a theory of situation awareness in dynamic systems. *Human factors*, *37*(1), 32–64.
[2] Salvucci, D. (2006). Modeling driver behavior in a cognitive architecture. *Human factors*, *48*(2), 362–380.
[3] Anderson, J. R., Bothell, D., Byrne, M. D., Douglass, S., Lebiere, C., & Qin, Y. (2004). An integrated theory of the mind. *Psychological review*, *111*(4), 1036.

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