The effect of train protection systems on train drivers' visual attention

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The model of attention deficits

Today, train protection systems are widely used to avoid critical situations in railway traffic. However, the train driver is still responsible for the continuous monitoring of signal aspects and the derivation of suitable actions. The question arises if, with train protection, also negative effects of automation may occur that reduce the capability to act quickly when necessary. Research so far shows evidence for negative attention effects, signals passed at danger (SPADs), inattention regarding signals, and late reaction regarding signals.

Based on that, Giesemann and Naumann (2015) developed a system related onset model of attention deficits. The model describes the attention processes and the interrelations of causes regarding attention deficits in the context of the train drivers' workplace (Fig. 1).

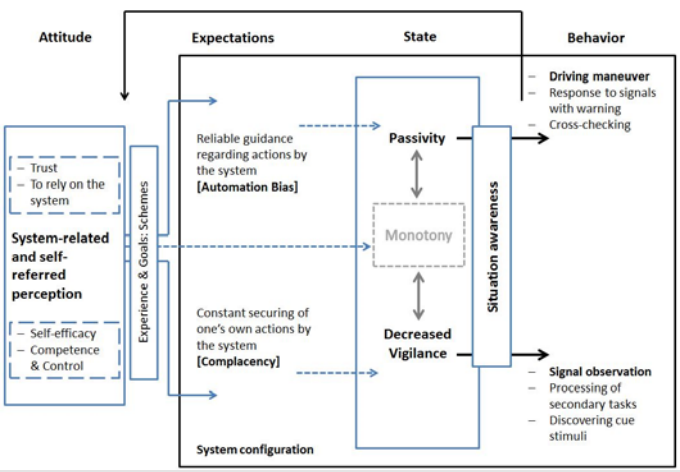

Figure 1. System related onset model of attention deficits (Giesemann & Naumann, 2015[2]).

Model validation

Method
In a simulator experiment (Fig. 2), the German **intermittent train protection system PZB was compared to a drive without train protection system**, regarding visual attention.
Participants: 20 experienced train drivers (mean age 31.5 years; SD=11), driving both conditions in a balanced within-subject design.
Task: Drive a 30min track according to a given timetable.
Recorded data: Gaze direction and driving performance.

Figure 2. Eye tracking with D-Lab 3.0. Defined AOI (Areas of Interest) top down: track, display, timetable.

Results
As assumed, the train protection systems leads to complacency effects (later start of decelerating) as well as a shift in visual attention from monitoring the rail track to the display when driving with train protection (Fig. 3 and 4). Also, there is less cross-checking between the information sources track, in cab display, and timetable.

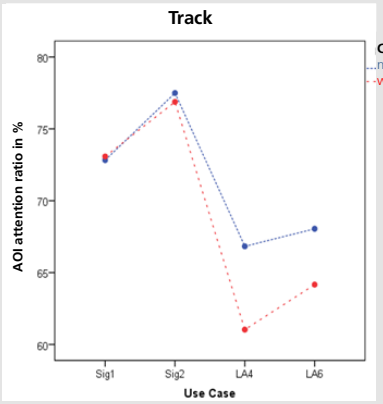

Figure 3. Ratio of visual attention on the track.

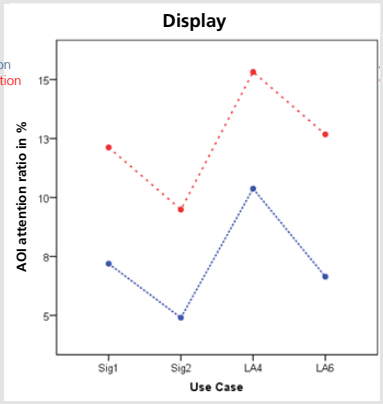

Figure 4. Ratio of visual attention on the display.

[2]Giesemann, S. & Naumann, A. (2015). Zugsicherungssysteme – Assistenz für Triebfahrzeugführer? Kognitive Systeme. DuePublico. ISSN 2197-0343.

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