Drivers' reliance on lane keeping assistance systems as a function of the level of assistance

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Advanced driver assistance systems are increasingly built in vehicles with the aim to support drivers while driving, to reduce driver errors and thereby to increase traffic safety. At present, these systems are often designed to warn drivers of specific safety risks (e.g., of an imminent departure from the driving lane). However, there is a trend towards systems that more strongly intervene in driving and that hence, automate parts of the driving task (e.g., autonomously keep the vehicle within the driving lane). However, research on human-machine interaction has shown that automation does not necessarily increase safety, but that it may also lead to unanticipated side effects on performance and safety to the extent that humans adapt to the changing task demands. A major concern in road traffic is that drivers rely too heavily on driver assistance systems, become less actively involved in the driving task, and divert their attention to things unrelated to driving. Thus, in the case of system malfunctions or failures, drivers possibly may not be prepared to intervene timely and accordingly and to regain control over the vehicle, respectively. The aim of this dissertation was to investigate changes in drivers' active engagement in the driving task as a function of the degree to which they are supported by a driver assistance system (i.e., as a function of the degree to which the system automates the driving task). Drivers' active task engagement was studied by referring to two theoretical concepts: a) drivers' reliance (on a system) and b) drivers' situation awareness. Based on an extensive review of previous research on automation, a conceptual theoretical framework was developed that links changes in operators' active task engagement to human adaptation processes on different levels in response to the changing task demands due to automation. Among them are changes in human attitudes as well as in cognitive, motivational and energetic processes. In order to determine the relative influence of these processes, a range of objective and subjective measures was collected. The essential part of the dissertation is an extensive driving simulator study in an advanced moving-base driving simulator at VTI (Swedish National Road and Transport Research Institute) in Linköping, Sweden. Two lateral support systems (a Heading Control system and a Lane Departure Warning system) were implemented which assisted drivers to different degrees in lane keeping. Contrary to most previous automation studies, drivers' reliance on the lane keeping assistance systems and their situation awareness were studied by using process-oriented performance-based measures. Drivers' reliance on the lane keeping assistance systems was assessed by eye glance behaviour measures indicating drivers' preparedness to allocate their visual attention away from the road scene to an in-vehicle secondary task. Drivers' situation awareness was assessed by behavioural measures of the latency and magnitude of drivers' initial reactions to unexpected critical driving situations. A major finding of the study was that drivers differed significantly in their reliance on a high level of lane keeping assistance. This interindividual variance in drivers' reliance on higher-level assistance could be best explained by drivers' trust in the system and their energetic arousal: The greater drivers' trust in the system and the lower their arousal, the more did they rely on the system. Individual driver variables (driving style) explained a significant proportion of the variance in drivers' trust in the lane keeping assistance systems.