Investigating the Effects of Alcohol Consumption on Manual and Automated Driving: A Systematic Review

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Introduction

Driving under the influence is a significant concern for public safety, leading to many tragic accidents. Alcohol impairs a driver's ability to process information at every stage, affecting their judgment and reactions on the road. Our research explores the correlation between driving under the effects of alcohol and its consequences while focusing on the role of automated vehicles (AVs). The primary research question addresses how alcohol affects driving performance in both manual and automated driving situations. The research findings will inform recommendations for future AV design and help improve the driving performance of human operators.

Study Methods

The research team conducted a systematic review of literature from eight databases, examining 53 articles in full text. The findings were categorized based on the three stages of the human information processing model and two other factors (predisposing and post-action consequences factors). There were very limited studies regarding AV takeover performance under the influence of alcohol, so the findings related to the AV takeover performance were summarized as the last section of the results.

Findings

These findings were categorized based on the stages of the information processing model and two other factors (predisposing factors, perception, cognition, action, and post-action consequences). Various blood alcohol concentration (BAC) levels affect driving performance differently during manual driving and during AV takeover scenarios. Examples of these impacts include delayed reaction times, postponed execution of driving tasks, and impacted driving abilities. Specifically, in terms of perception, some articles investigated a driver's performance in terms of their reaction time in perceiving driving conditions (e.g., traffic lights or pedestrians). These studies also used physiological measurements, such as eye movement or blink rate, to prove the various negative impacts of alcohol. Regarding cognition, studies

included divided attention tasks and found poor driving performance as well.

For the action stage, many studies found that drivers under the influence of alcohol have a low vehicle control ability (e.g., a higher standard deviation of lane position) compared to sober driving. Additionally, factors such as a driver's driving experience, drinking patterns, or external driving environment can also be important. For instance, studies found that experienced drivers have better vehicle control abilities than novice drivers after drinking. Therefore, studies confirmed that alcohol affects all the stages of the information processing model, which illustrates increased driving risk. However, existing research tests limited levels of BAC and lack studies on AV takeover performance, especially with higher levels of automation. Future research should explore the driving performance in a higher level of automation. Moreover, some studies only recruited drivers with at least two years of experience, which excluded novice drivers. Since there are significant findings from other studies that the alcohol influence between experienced and novice drivers can be different, studies may consider including novice drivers to make their study more inclusive.

Insights into the effects of alcohol on the AV takeover process highlight the need for future research in this area.

Policy/Practice Recommendations

Based on the findings from the literature, we provided a few recommendations for future work and possible technology that can be installed in a vehicle. Future work could focus on understanding AVs and takeover performance at different BAC levels in higher levels of automation. For example, driving in conditional automation, in which the vehicle can take care of most of the tasks, a human driver needs to remain alert. However, when drivers are impaired by alcohol, their ability to perceive the request from the vehicle or to take control may be impacted. Therefore, understanding alcohol's effects in higher automation is vital. Regarding higher automation that doesn't require any tasks for human drivers, future studies should still explore the communication between the passenger and the AVs, such as how the in-vehicle system in AVs effectively interacts with the impaired passenger. Following that, developing in-vehicle systems to monitor drivers' behavior, such as based on the driver's physiological data, to predict driver's BAC level and initially prevent drunk driving. Our study offers potential implications for future experiments and AV technology design.

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