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A qualitative examination of drivers' responses to partially automated vehicles

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ABSTRACT

There has been an increase of automated vehicle (AV) technologies in recent years. Using qualitative methods, this study explored drivers' responses to the experience of AVs centered on theoretical themes of trust, particularly around ability, helpfulness, and integrity as well as individual factors of identity, norms, and efficacy. Participants (n = 68, Mage = 43. 2 years) first completed a 20-minute drive in an advanced high-fidelity driving simulator that simulated driving an AV with intermittent periods of manual vehicle control. Participants identified consideration of financial concerns and described a need to trust that the AV system worked as expected and that it would function similar to human drivers, including their speed management. They also identified trust with regard to potential benefits (helpfulness regarding mobility and secondary task performance). Hacking and privacy were identified integrity issues, although primarily privacy was not considered relevant to their behaviour. The findings from participant interviews also revealed that individual difference constructs around identity (as an early technology adopter or 'car' person), social norms, and efficacy were important factors in their intentions to drive or own a fully AV. Finally the participants described emotive outcomes, relating to benefits of relaxing or reducing stress and use being fun and safe. Overall, these findings provide some insights into the way in which drivers' describe the benefits and potential concerns associated with emerging AV technologies.

1. Introduction

It has been estimated that road crashes account for 1.25 million fatalities annually worldwide, with an additional 20–50 million people injured (World Health Organization, 2017). Automated vehicles (AVs) have been proposed to reduce crashes, including those related to risk-taking behaviors such as, drink driving or driver distraction. In addition, AVs may increase mobility for groups such as older drivers or those with disability (e.g., Becker & Auxhausen, 2017). There is an emergence of available AV technologies, with vehicle trials well underway in many countries. Correspondingly there is a need to explore driver's perceptions about AV and this study qualitatively explored beliefs after a driving simulation task that included transfers of control (Level 3, SAE International Standard J3016).

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To date, research examining perceptions of AVs has been dominated by survey studies that may provide scenario examples of AVs or brief descriptions that may be open to different interpretation (see review by Becker & Auxhausen, 2017). There are exceptions with some qualitative research, such as that by Brinkley, Posadas, Woodward, and Gilbert (2017) who conducted focus groups with people with vision impairment, finding that participants were excited about AVs however described concern (e.g., that their specific needs may not be considered). Robertson, Meister, Vanlaar, and Hing (2017) included a focus group component involving 25 drivers, non-driving older adults, and adults with physical disabilities who commented that AVs might be 'annoying' or not to their style of driving.

There are other exceptions to the use of surveys, including Payre, Cestac, and Delhomme (2016) who used a driving simulator of a fully AV (Level 5, SAE International Standard J3016) and found differences in the relationship between reaction time and trust with different instructions (i.e., higher trust and longer reaction time with simple instruction but not elaborate instruction). Albert, Lange, Schmidt, Wimmer, and Bengler (2015) included a test-track study (Level 3 automation, SAE International Standard J3016) finding that participants had a preference to transfer more tasks to the vehicle, they surmised value in focusing on comfort and that loss of human control played a minor role in acceptability. In contrast, Bjørner (2017) used videos to present technology in a qualitative study and highlighted the importance of context including emotion around driving identity and freedom as well as the importance of trust. Findings thus suggest value in considering trust as well as emotion and highlighting relevance and comfort with AVs.

Dominant survey work however, has highlighted some key findings about AV perceptions (e.g., Kyriakidis, Happee, & de Winter, 2015). One study by Payre, Cestac, and Delhomme (2014) reported that intention to use fully AVs was associated with fewer costs and greater benefits (i.e., pleasant, useful, free of danger), contextual acceptability (i.e., preference for control, beliefs about safety, secondary tasks), and interest regarding impaired driving. Other studies have highlighted the relevance of family and friends' expectations (Madigan et al., 2016), technology usefulness (Rahman, Lesch, Horrey, & Strawderman, 2017) and ease of use (Robertson et al., 2017). Further, Haboucha, Ishaq, and Shiftan (2017) identified key themes that included interest in technology and enjoyment in driving (as well as environmental concern and attitudes toward public transportation) that distinguished those wanting to shift to AV (private or shared) for commuting. There are further studies that highlight affect, with emotional response (pleasure and anxiety) moderating sex and age perception differences (Hohenberger, Spörrle, & Welpe, 2016). As identified in review studies (e.g., Merat & de Waard, 2014) there appears importance in considering comfort, emotional experiences, as well as perceptions around vulnerability and interests (e.g., in mobility, technology, and driving).

Trust is recognised as a major challenge to the uptake of AV and is commonly considered in AV research (e.g., Choi & Ji, 2015; Gold, Körber, Hohenberger, Lechner, & Bengler, 2015; Verberne, Ham, & Midden, 2012). The concept however has been defined and measured in multiple ways yet despite variations across disciplines most recognize a context of uncertainty and vulnerability. Trust is thus conceptualised as a solution to a problem of risk or an internal calculation of conditions of uncertainty (Luhmann, 2000), that is while drivers do not understand the complexity of engineering they must trust operation in traffic and seek to reduce uncertainty.

Typically multi-dimensional conceptualisations of the context of trust include three elements to understand action in the face of uncertainty: (i) ability, or competence, that is the AV system would have necessary features to complete the desired action; (ii) helpfulness or benevolence, that AVs are responsive, relevant, and achieve operators goals; and (iii) integrity, that AV fulfils promise, is transparent, and is predictable (Choi & Ji, 2015; Lee & Moray, 1992). That is, AV does what it's supposed to do, is helpful, and is reliable. These three dimensions are observed in other automated technology studies, and relatedly in interpersonal trust research (see Lee & Moray, 1992). Choi and Ji (2015) examined three components of trust (technical competence, situations management, and system transparency that align with ability, helpfulness, and integrity) and found that 47% of the variance in the likelihood of using AVs were predicted by these three components. Further, the study found that there was a significant moderate positive relationship between trust and intentions to use AVs, suggesting that higher trust scores were associated with greater intentions. It is not however clear how potential drivers experience these elements.

Trusting behaviour thus involves relinquishing some control and investing in outcome expectation to another. Tanis and Postmes (2008) argue that expectations can also be created around identity. Studies thus include a trait or individual disposition around likelihood of trust. Such individual difference in propensity might be reflected in the way the three context elements are interpreted and theoretically it could be suggested that identity might shape individual difference in propensity to trust. Other cognitive factors, such as efficacy may shape AV perceptions (Hohenberger et al., 2016). Self-efficacy can be considered as a cognitive process that an individual has confidence that they can perform a task, for example, effectively and easily use AV (Neubauer & Schauer, 2017). Schaefer and Straub (2016) suggests constructs such as efficacy provide a description of the cognitive process of interpreting context, that is the interaction of trusting AV ability and individuals resources to operate the technology. Efficacy beliefs (or self-enhancement) have been shown to mediate feelings of anxiety associated with willingness to use AV as well as anxiety and beliefs about AV benefits (Hohenberger et al., 2016).

Qualitative research may offer detail regarding the underpinning of perceptions towards AVs and a deeper understanding of constructs that are used in survey research. This qualitative study was largely exploratory, designed to assess experience with automated driving in an advanced driving simulator (Level 3, SAE International Standard J3016). Specifically, the aim of this study was to explore responses to AV experience focusing on trust in AV, in particular the three components of ability, helpfulness, and integrity as well as individual difference consideration related to identity, social norms, and efficacy. We also seek to explore the emotions described around AV use.