

Do I Need A Tune-up? An Experimental Study of App Usage on Driving Performance Improvement

Research-in-Progress

Xinyu Tan

School of Information Management,
Nanjing University, 163 Xianlin Road,
Qixia District, Nanjing, China
181820222@smail.nju.edu.cn

Yiyang Bian

School of Information Management,
Nanjing University, 163 Xianlin Road,
Qixia District, Nanjing, China
bianyiyang@nju.edu.cn

Xiaoxiao Ma

Heilongjiang broadcast TV station
333 Hanshui Road, Harbin, China
maxxmaggie@hotmail.com

Abstract

Information technology is playing an increasingly essential role in reducing driving risk by helping individuals improve their safe driving behavior. The purpose of this research is to empirically examine the effects of IT, exposure to mobile app usage, on individual's driving behavior changing. Based on motivational theory, this study investigates how driving-assistant app usage influences driver's behavior and further influences their driving performance. A field experiment is designed to collect the individual app usage and driving data from 200 drivers. The research results will benefit both IT designers and drivers theoretically and practically.

Keywords: App usage, behavior changing, driving performance, Motivational Theory

Introduction

With the development of *Internet of Vehicles* (IOV), more and more organizations seek to leverage information technology to improve driving behaviors. It is acknowledged that the diffusion and deepening of the IT revolution is a hallmark of the emerging 'information age' (Castells 1997). Moreover, the rapid development of IT brings many gadgets with it, such as mobile apps (Joorabchi et al. 2013; Mahmood et al. 2001; Nishad and Rana 2016). People use these IT products and applications for different purposes. And not surprisingly, as people use IT more frequently, researchers are studying the effects with growing interest (Greengard 2011).

Prior studies have put emphasis on positive effective IT, including promoting the development of health care, education, business, communication, entertainment and global connectivity (Chen 2020; Cole-Lewis and Kershaw 2010; Green and Bavelier 2008; Hitt and Brynjolfsson 1996). Researchers started to explore how to use IT to influence human behavior (Årsand et al. 2010; Hebden et al. 2012; Hughes

et al. 2010; Mattila et al. 2009; Sundaram et al. 2007; Varnfield et al. 2011). However, there is still a lack of its application for the purpose of improving driving safety. Thus, this study plans to assess the IT effects on individual driving behavior changing by investigating the research question of whether the app usage, drivers' desire and characteristics can have some influence on their individual driving performance and how such change occurs.

Literature Review

IT Usage and Behavior Changing

A typical objective of most prior IT research is to explain the factors influencing the IT usage and acceptance. Researchers have built and tested several theoretical models of IT usage, such as *theory of planned behavior* (TPB), and the *technology acceptance model* (TAM) (Taylor and Todd 1995; Venkatesh et al. 2003). Another major objective of IT research is to assess the value of IT in terms of organizational performance. Studies show that IT usage is a key driver of good organizational performance. For example, it can effectively improve productivity (Devaraj and Kohli 2003; Hitt and Brynjolfsson 1996) and allow for company-wide emission reductions (Pablos 2012).

The past decades also witnessed the successful application of IT products for individual behavior changing in certain fields. For instance, in the field of public health, Mattila et al. tried to record self-management of weight-related behaviors (Mattila et al. 2009), Hughes et al. developed an app for monitoring energy balance (Hughes et al. 2010), and others have monitored diet or physical activity as part of a program for diabetes (Årsand et al. 2010) or cardiac rehabilitation (Varnfield et al. 2011). When it comes to commerce, Sundaram et al. suggested that the effective and efficient use of technology enhances salesperson performance (Sundaram et al. 2007). Furthermore, researchers in the area of decision support systems, methods and techniques (Mladenec et al. 2003; Power 2002) convinced that IT can support people faced with decision-making problems and tasks to decide better, faster and more effectively (Bohanec 2009). However, when exploring ways to avoid driving risk, few researchers have reported on the use of IT products and applications for behavior changing at the individual level.

Driving Risk

Prior studies have assessed various contributing factors in to driving risk, which is defined as a potential threat that may cause vehicle crashes or other accidents (Zheng et al. 2014). Researchers conclude the factors to drivers' driving behaviors, traits, the road condition, environment state and vehicle failures (Cai et al. 2016; Donovan and Marlatt 1982; Donovan et al. 1988; Rolison et al. 2018). From the perspective of drivers themselves, research distinguishes between driving skills and driving style (Rolison et al. 2018). The skills component includes practice, exposure to the diversity of traffic situations and reaction time (Boyce and Geller 2002; Lajunen and Summala 1995; Li et al. 2016; Özkan and Lajunen 2006). Driving style refers to the ways an individual chooses to drive (Rolison et al. 2018). Driving characteristics, a complex interaction of driving skills and styles, are explained in prior studies. For example, driving experience was confirmed to be a significant predictor of safety and skill-oriented driving (Lajunen and Summala 1995), for which researchers explain that practice and increased exposure to diverse traffic situations could be expected to improve driving performance, but also increase subjective control over driving and reduce concerns about safety (Näätänen and Summala 1976; Spolander 1983). Additionally, age is also related to driving experience, thus many of the younger drivers tend to have higher driving risk compared to older drivers (Sharkin 2004).

Efforts have been taken to improve driving risk assessment (Bian et al. 2018). However, traditional ways to reduce driving risks are not taking full advantage of technology. Given that mobile apps are a novel technology that can be used to deliver behavior change interventions directly to individuals and have the potential to make a difference (Hebden et al. 2012), and little research explores the IT in terms of human driving behaviors, this study will investigate the relationship between individual level driving behavior changing and app usage behavior of the drivers.

Theoretical Foundations

Although research on the impact of mobile apps on individual behavior is still relatively young, theory on factors for arousing and directing a person's behavior exists (Halepota 2005; Hull 1943; Iso-Ahola 1980), and a group of the theories is emerging as an appropriate lens for its examination (Chang et al. 2013; Lee et al. 2005). Since the 1970s, Richard M. Ryan and Edward L. Deci have started researching on motivational theories. They generated the definition of two important types of motivation, intrinsic motivation and extrinsic motivation, from prior theories (Deci 1972; Deci and Moller 2005; Deci and Ryan 2010; Ryan and Deci 2000). Intrinsic motivation is a type of motivation based in people's natural interest in various activities that provide novelty and challenge, and extrinsic motivations focus on the outcome of the activity, i.e. individuals are driven by the outcome rather than the activity itself (Deci and Ryan 2010; Moon and Kim 2001; Ramayah et al. 2003). Over the past decades, people's intrinsic and extrinsic drives have been utilized to explain individual behavior. For example, researchers put perceived enjoyment, perceived ease of use as intrinsic motivation while perceived usefulness as extrinsic motivation of internet usage (Lee et al. 2005; Moon and Kim 2001; Ramayah et al. 2003; Teo et al. 1999; Zhang et al. 2008). In addition, Steg and Vlek concluded two kinds of external interventions that help modify people's behavior (Steg and Vlek 2009). One is structural strategy, aiming to change external factors such as policy and technology. The other is called informational strategy, aiming to influence perceptions and knowledge. Specifically, structural strategies try to change the external context in which choices are made, while informational strategies target increasing actors' knowledge so as to heighten their awareness of the impacts of their behavior, and/or providing social support and role models to strengthen social norms, and informing actors about the perceptions, efficacy and behavior of others.

In our research, the participants will have access to an app which will send an alert to them when it detects risky driving behavior and provide a performance ranking at the end of the day. Considering that the app has feedback and reminder functions, we will take the app as an informational strategy, which means we'll view the app as a prime extrinsic motivator for individual behavior changing. What's more, the desire to using our app and improving their driving behavior reflects drivers' intrinsic motivation. In short, as our participants' different behavior of app usage, desire to improve driving performance and actual changes of driving behavior can be clearly observed.

Research Model and Hypotheses Development

Based on motivational theory, this research investigates the effects of mobile app usage and the desire to improve oneself on the individual's driving performance, moderated by the individual's driving habit. Our research model is illustrated in Figure 1.

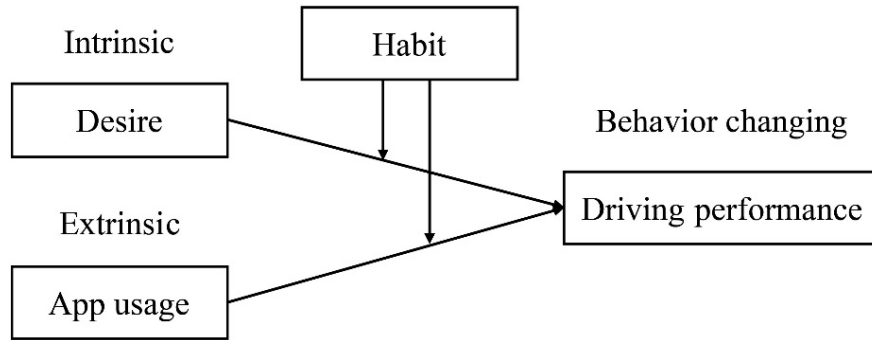


Figure 1. Research Model

According to Figure 1. A relatively high self-reported desire for receiving feedbacks reflects their greater concern about driving safety and brings with its greater intrinsic motivation to improve their driving performance. According to the motivational theory, such intrinsic drives explain in part individual behavior, and will lead to better driving performance in the context of our experiment. Thus, we hypothesize:

H1: Users with higher desire to improve their driving skills will have a better driving performance.

The app informs drivers of their driving behaviors every day by giving feedback and provides a means of mutual supervision between users. This feedback provides drivers with specific knowledge of their driving performance and heightens their awareness of the risks of their behaviors. Additionally, the mutual supervision between users helps build role models and strengthen certain social norms (Steg and Vlek 2009), thus restraining drivers' poor driving behaviors. In summary, as a form of extrinsic motivation, the app might drive users to change their behaviors. Thus, we hypothesize:

H2: App usage is positively correlated with better driving performance.

According to research on driving risks, individual road users differ in their personal balance between perceived safety and physically or statistically determined safety for various reasons, cognitive, motivational, as well as physiological (Kleibelsberg 1977; Michon 1985). Specifically, increasing driving experience and exposure to traffic enhances the sense of subjective control and decreases the concern for safety aspects (Näätänen and Summala 1976; Spolander 1983). Drivers with richer driving experience tend to form a driving habit, exhibiting characteristics of a learned behavior. Once such driving habit has been developed, it might be difficult to change (Duhigg 2012). Hence, experienced drivers tend to develop a fixed driving habit and are more skilled at driving but need every effort to change their driving styles. Novice drivers, on the contrary, will tend to have a lower sense of control on their driving skills while they can change their driving styles more easily. Although their intrinsic motivation and extrinsic intervention by the app may drive people to change behaviors, the effects are affected differently by drivers' driving habits. In other words, it will be easier for drivers with a fixed driving habit to situationally adapt behavior because of rich driving experience, while it is less likely to have them influenced by external app usage because they have formed fixed behavior patterns. Thus,

H3a: A more fixed driving habit will enhance the relationship between user's desire to change individual behavior and driving performance.

H3b: A more fixed driving habit will weaken the relationship between App usage and driving performance.

Methodology

Experiment Design and Data Collection

The hypotheses will be tested by a field experiment with the use of a 2 x 2 x 2 between-subjects design. In the first step, treatments are app usage (yes versus no), and desire to improve driving skills (high desire group versus low desire group). What's more, we will randomly assign the drivers based on their characters to the 4 groups based on their demographic information (each group has 50 subjects). 400 different drivers will be observed by using a driving-assistant app named "hujiabao" over 3 months. Meanwhile, their driving behavior will be collected using on-board devices. Variables such as the participants' age, gender, type of car will be obtained through the app. We will first distinguish novice drivers from experienced drivers by the criteria of the median of all drivers' driving experience (Brown and Groeger 1988; Underwood et al. 2003), and in the following experiment, drivers will be randomly assigned to each group based on their driving habit. Then participants will be provided with a mobile app that we designed for the experiment and be asked to log in if using the app. In Group1 and Group2, different behaviors of app usage (whether have used or not) in a given day will be observed. Subsequently, individual driving behavior will be measured and recorded respectively. In the second step, the basis for grouping will be driving habit (novice drivers versus experienced drivers) and in different groups, we will examine the joint effects with observations' intrinsic and extrinsic motivations on driving performance.

Measures

Drivers' driving performance is defined as the action or process of performing a driving task (Roenker et al. 2003) that is measured by individual driving score given by the app. The score is calculated per day based on driver's daily driving behavior including Speed, acceleration, deceleration, sharp turn, fatigued driving, etc. App usage is defined as whether a driver has used the app during experiment (Taylor and Levin 2014) and measured by the individual check-in status in the app on a given day. Desire is measured by the degree of desire to improve individual driving performance and be collected on their first log-in. In addition, driving habit will be seen as a moderating variable measured by individual driving experience. Control variables are considered to ensure the model robustness, including weather, demographic information of drivers and driving time.

Conclusion

This paper contributes to contemporary knowledge about the impact of IT on individual behavior changing. We believe the findings of our research will (1) extend the motivational theory by applying it to driving behavior changing; (2) provide insights of the impact of IT on individual behavior; (3) offer suggestions to drivers for choosing their appropriate function settings and to relevant IT developers to make a useful app function design for driving performance improvement practically.

Acknowledgements

This research was supported by grants from the Natural Science Foundation of Jiangsu Province (No. BK20200339), Shenzhen Special Fund for the Development of Strategic Emerging Industries (No. JCYJ20170818100156260), research fund of Science and Technology Department of Sichuan Province (2020YFSY0061), National Natural Science Foundation of China (Nos.: 71932002 and 72031001).

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