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Intention to use a fully automated car: Attitudes and *a priori* acceptability

William Payre [a,b,*], Julien Cestac [b], Patricia Delhomme [b]

[a] *VeDeCom Institute, 77 rue des Chantiers, 78000 Versailles, France*
[b] *French Institute of Science and Technology for Transportation, Development, and Networks (IFSTTAR), Department of Planning, Mobilities, and Environment, Laboratory of Mobility and Behaviour Psychology, France*

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ABSTRACT

If previous research studied acceptability of partially or highly automated driving, few of them focused on fully automated driving (FAD), including the ability to master longitudinal control, lateral control and maneuvers. The present study analyzes *a priori* acceptability, attitudes, personality traits and intention to use a fully automated vehicle.

421 French drivers (153 males, $M = 40.2$ years, age range 19–73) answered an online questionnaire.

68.1% Of the sample *a priori* accepted FAD. Predictors of intention to use a fully automated car ($R^2 = .671$) were mainly attitudes, contextual acceptability and interest in impaired driving (i.e. the two components of FAD acceptability), followed by driving related sensation seeking, finally gender.

FAD preferred use cases were on highways, in traffic congestion and for automatic parking. Furthermore, some drivers reported interest in impaired driving misuses, despite awareness of their responsibility for both the vehicle and the driving. These results are discussed regarding previous knowledge about acceptability of advanced driving assistance systems and consequences for the use of fully automated cars.

1. Introduction

1.1. Partially and fully automated driving

Automated driving aims specifically at increasing road safety, reducing traffic congestion, gas emissions and fuel consumption (European Commission, 2011). Thus research concerning civil vehicle automation is crucial. It started in Europe in the late 80s with the European EUREKA Prometheus project which contributed to the conception of the first driverless cars. Since then, many automated prototypes had been constructed and had driven efficiently on different kind of roads in a highly automated mode i.e. mastering both longitudinal and lateral control with few supervisor interventions. For example, the Defense Advanced Research Projects Agency (DARPA, 2005) consisted of a 132 miles race in the desert completed by autonomous cars. The Citymobil research, development and demonstration project aimed at integrating automated transport systems in the urban environment (van Dijke & van Schijndel, 2012). Interest in automated driving still

* Corresponding author at: IFSTTAR, Planning Mobilities Environment Department, Laboratory of Mobility and Behaviour Psychology, 25, allée des Marronniers – Satory, 78000 Versailles, France. Tel.: + 33 1 30 84 39 55.
E-mail address: william.payre@ifsttar.fr (W. Payre).

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grows, as shown by the 9th ITS European Congress (2013) which organized a special interest session dealing with highly automated vehicles, highway trucks and cars platooning, as well as automated urban transportation.

A distinction must be made between the different levels of automation in driving. Regarding partially automated cars, the terminology is varied: automated driving, partially automated driving and highly automated driving (e.g. Jamson, Merat, Carsten, & Lai, 2013). Concerning public policies, the National Highway Traffic Safety Administration (NHTSA) provided a framework describing five different levels of driving automation (National Highway Traffic Safety Administration, 2013), ranging from 0 (i.e. No-Automation) to 4 (i.e. Full Self-driving Automation). Fully automated driving (FAD) refers to a vehicle able to drive autonomously without any intervention from the driver, or anyone else in the vehicle, as soon as the fully automated mode is activated (e.g. NHTSA's levels 3 and 4). In a fully automated car, longitudinal control (i.e. headway between vehicles and speed), lateral control (i.e. position in the lane) and maneuvers (such as overtaking and braking) are handled by the system, not by the driver. One of the most famous FAD project concerns Google's self-driving car, considered level 3 – limited self-driving automation by the NHTSA. This car is able to drive autonomously in fully automated mode in Nevada and California since 2011 (Guizzo, 2011), albeit the presence of an engineer is required by law at the driver's seat. Renault announced in 2013 that they would commercialize before 2020 a car with a driving delegation device efficient up to 30 km/h (Boutelier, 2013). Concerning medium speed automation, Audi presented during the International CES 2014 in Las Vegas a prototype of the *Piloted Driving* system, which allowed drivers to use this system in heavy traffic, up to 40 mph (64 km/h). This device would be available by 2016.

Nowadays, drivers have the opportunity to buy new cars with different automated driving features, such as Adaptive Cruise Control (ACC, see Saad et al., 2004 for a review on the device), Lane Keeping System (LKS), or even Stop and Go device which matches the speed of the car in front in low speed traffic and can also stop and restart the vehicle by itself. These devices make the driving partially automated. Indeed, the driver is assisted, and sometimes substituted, by an electronic system to perform some of the driving tasks, such as mastering longitudinal and lateral control (ACC, LKS), threshold and cadence braking (ABS), or even automatic braking while skidding (ESC).

Since fully automated cars are not commercialized yet, it is important to examine acceptability, attitudes and drivers' intentions toward FAD. Regarding these topics, the highest levels of driving automation have not been entirely addressed yet. Hence, theory about intention, behavior and technology acceptability will be introduced, as well as previous research concerning partially automated driving that focused on attitudes, acceptability and behavioral adaptation. Afterward, the results of the empirical study on the intention to use FAD will be presented.

1.2. A priori acceptability, attitudes and intention to use automated driving

A priori acceptability of a technology can be defined as the evaluation of that technology before having any interaction with it. Technology acceptability deals specifically with perceived usefulness and perceived ease of use (Davis, 1989). Technology *a priori* acceptability should be addressed considering the evaluation of the technology itself and the methodology used to evaluate it (Bagozzi, 1981), as well as its potential uses, which is possible (Laurencin, Hoffman, Forest, & Ruffieux, 2004; Terrade, Pasquier, Reerinck-Boulanger, Guingouain, & Somat, 2009).

The Technology Acceptance Model (TAM) (Davis, Bagozzi, & Warshaw, 1989) adds more precision on the way to evaluate a technology. It postulates on the one hand that intentions to use a technology have an incidence on usage behavior, and on the other hand that perceived ease of use and perceived usefulness determine intention to use. Moreover, behavioral intention can be predicted by attitudes (Albarracín, Johnson, & Zanna, 2005; Fishbein & Ajzen, 1975). Attitudes can be defined as *a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor* (Eagly & Chaiken, 1993, p. 1). It seems reasonable thus to expect that the intention to use a technology/object could be predicted to some extent by users' attitudes and by its *a priori* acceptability, especially because *a priori* acceptability and attitudes are correlated (Parasuraman, Singh, Molloy, & Parasuraman, 1992).

Attitudes are globally positive toward simulated partially automated driving systems (de Waard, van der Hulst, Hoedemaeker, & Brookhuis, 1999; Nilsson, 1995; Stanton, Young, & McCaulder, 1997). In addition, delegating driving can be appealing when a journey is considered monotonous or unpleasant (Fancher et al., 1998), confirming that use cases have a major role in Advanced Driving Assistance Systems (ADAS) acceptability. Indeed, traffic congestion and highways seemed to be situations in which using partially automated driving would have benefits on driving comfort, according to studies on ACC (Saad & Villame, 1996). Finally, men are more inclined than women to use technology (Venkatesh, Morris, & Ackerman, 2000). Nonetheless, the authors did not report the effect of age on technology acceptability in this study.

Furthermore, ADAS that decrease control on driving (e.g. decision making) may have less chance to be accepted by drivers (van der Laan, Heino, & de Waard, 1997). Indeed, although ADAS are evaluated positively as useful and safe, drivers have a negative judgment on people choosing to use such driving assistance systems because they think that they are considered drivers with poor skills (Lefeuvre, Bordel, & Guingouain, 2008). This contrast might be in conflict with the development of automated driving systems because in the partially automated mode, the driver does not directly control the classic driving tasks such as navigation, control or hazard identification (Stanton, Young, Walker, Turner, & Randle, 2001). This could lead to a rejection of driving assistance technology, and stresses the paradox between positive subjective evaluation of a technology and the weak intention to use it. However, the fully automated level of driving is able to substitute the driving system for the driver; he/she might then think he/she is not assisted but substituted by the automated driving system. Thus, being substituted might lead to either rejection or approval of the automated driving system, depending on the personality traits of the driver.

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