
Designing for Personality in Autonomous Vehicles: Considering Individual's Trust Attitude and Interaction Behavior

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Abstract

In this paper, we discuss the role personality traits, a concept from the domain of psychology, play in trust and the interaction with autonomous vehicles. Human's trust in autonomous systems and smart devices gains significant importance for successful interaction. However, humans experience this trust and interaction individually, requiring careful design for diverse user needs. Thus, when designing for autonomous vehicles we argue that the driver's personality should be carefully examined and addressed.

Author Keywords

Autonomous vehicles; Personality traits; Big 5; Trust; Human-machine interaction

Introduction

When humans interact with autonomous machines, they abandon control and allow the machine to make decisions together. Therefore, humans have to accept and trust the machine to perform the given task [44, 46]. This trust is especially important for autonomous vehicles since even small driving lapses can result in serious accidents [44, 25, 54]. Yet, not all users respond with the same trust to automation. Individual human traits can influence this experience [46]. These individual characteristics include age [34], gender [29, 48], and cultural background [37]. Moreover, previous work suggests that personality traits influence humans' trust

in machines as well as their interaction with them [46, 44, 21].

The concept of personality traits derives from psychology and is characterized by being stable and cross-situational [1]. Personality traits predict various behaviors and attitudes, including driving behavior, information seeking, and communication [33]. The role of personality traits in trust and interaction with automated machines has already been established in previous research [22]. In this paper, we discuss the role of personality traits for the design and interaction with autonomous vehicles. In the following section, we will give an overview of the most prominent personality model and the influence of personality traits on driving behavior. Afterwards, we will introduce previous findings on the effect of personality traits on trust in autonomous systems and interaction behavior with smart devices. Based on these results, we suggest several implications for the design of autonomous vehicles regarding personality traits. Later on, we briefly discuss limitations and future challenges.

Personality Models

Describing people's personality is a major challenge in empirical psychology [48]. The most prominent personality theory is the five factor personality model or commonly known as *Big Five* [8, 19]. Individuals' tendencies of behavior and attitude are described on the five dimensions *Extraversion*, *Neuroticism*, *Agreeableness*, *Conscientiousness*, and *Openness*.

Individuals high in extraversion are outgoing, active, and enjoy the interaction with others but bore more easily when not stimulated externally [13, 38, 3]. The dimension neuroticism refers to the frequency of experiencing negative emotions [1]. Highly neurotic individuals tend to be more anxious, depressed, frustrated, and stressed [1]. Agree-

ableness is associated with individuals' interpersonal relationships and empathy. Individuals high in agreeableness tend to be cooperative and socially harmonic, avoiding conflicts [31]. The dimension conscientiousness describes a tendency to be thorough, careful, organized, and responsible [30]. Openness is related to individuals who appreciate new experience and novel stimuli. They also tend to be more creative [12].

The connection between personality traits and driving behavior as well as their role in traffic accidents has been known since the 1960's [51, 17, 7]. One of the most established connections is between neuroticism and aggressive driving, causing serious accidents. Aggressive driving emerges from highly neurotic individuals' behavior. For example, individuals high in neuroticism are easily distractible and provoked as well as absorbed with their own anxieties [10, 9, 51]. Extraversion is positively correlated with risk taking, such as speeding and violating traffic regulations [4, 43]. In contrast, individuals high in agreeableness, who value cooperation and social harmony, are usually not aggressive drivers [9, 28]. It is no surprise that conscientiousness and the concomitant discipline is an effective negative predictor of aggressive driving [9, 32]. Individuals high in openness to a level that they need to experience excitement and danger, are called *sensation seekers* [55], which has a strong relationship with aggressive driving and traffic violations [50]. However, although several researchers pointed out the effect of personality traits on driving behavior [52], there can be found mixed results regarding the magnitude and significance of this influence [51, 28].

The Effect of Personality Traits on Autonomous Machines and Smart Devices

The importance of trust in interactions between humans and automated machines has already been established

[46]. Evans and Revelle showed an effect of extraversion and emotional stability on trust development in a robot [16]. Haring et al. also discovered that extraverted individuals reported higher trust in humanoid robots [23]. In contrast, Salem et al. could not confirm these findings since they did not detect any relationships between personality traits and robot trust development. Instead, they found that individuals high in extraversion and emotional stability anthropomorphized the robot more and felt close to it [45]. Hancock et al. attributed the greatest influence on trust in human-robot interaction to the design of the robot and found only little evidence for an impact of human characteristics [22]. Walters et al. examined approach distances between humans and robots. According to their findings, the majority of humans (60%) is most comfortable with distances similar to human to human interaction [53]. However, among the remaining 40% of users, a positive correlation between preferred distance and activeness was detected [53].

Apart from trust, preliminary evidence was provided for the influence of personality traits on interacting with smart devices. Several previous findings pointed out a connection between personality traits and the usage of smart devices, such as smartphones [49, 3, 5, 11]. Stachl et al. showed that personality traits were a better predictor of application usage than simple demographic variables [49]. For example, findings revealed that extraversion is correlated with higher use of communication and entertainment apps as well as camera use [49, 5]. Furthermore, an effect of personality on intention to use smart glasses [42] and preference for intelligent personal assistants [15] was determined.

Designing for Personality in Autonomous Vehicles

Findings from human-robot interaction indicate that not all users perceive trust in automated machines similarly.

Hence, we suggest that the effect of personality traits on acceptance and trust in autonomous vehicles has to be examined carefully to address individual user needs differently. For example, first findings from a study, collecting the opinion of 5.000 participants on automated driving, revealed that individuals high in neuroticism were more anxious about data transmitting in autonomous cars whereas more agreeable respondents were more comfortable with it [37].

To increase trust in autonomous vehicles, the actions of the car should be explained carefully to the passenger [35, 25]. Similar positive effects of explanations to improve the general acceptance, perceived quality, and effectiveness of the interaction were found for intelligent systems such as recommender systems [18]. Since personality traits also have an influence on information seeking and competence [33, 26, 27], we once again argue that these explanations – their design, frequency, and level of detail – should be adapted to driver's personality. For example, individuals high in neuroticism have difficulties with evaluating the quality and relevance of an information and tend to quickly skim information, avoiding high effort and deep delving into the topic [27]. To support these drivers in critical situations, e.g. take over requests, confirming and clear information should be provided, which reassures the driver and is not distracting. Individuals high in extraversion in combination with openness to experience and low agreeableness (competitiveness) are characterized as *broad scanners*, who are exhaustive information seekers using a wide range of sources, including social contacts [27]. For these drivers, explanations could be provided in form of an intelligent assistant, who takes over the role of a friend. Individuals low in agreeableness are competitive and competent to critically analyze information. However, due to their impatient character, they tend not to put too much effort into the search

[26]. For these users, only important information and explanations should be delivered briefly and precisely. Eventually, it is not surprising that individuals high in conscientiousness are *deep divers*, hard working and trying to obtain high quality information [27]. Apart from the immense effort they put into the search, they also pay attention to the quality of the retrieved information and follow a structured deep analysis approach [26, 20]. They are also distinguished by information competence [47]. It is likely that these drivers appreciate more profound information, which explains the overall context of the car's behavior.

Apart from trust and explanations, personality can also affect other interaction areas in autonomous vehicles. Users prefer different driving styles when driving manually as well as autonomously [36]. However, Basu et al. showed that drivers preferred a less aggressive driving style in autonomous cars than their own [2]. Since an aggressive driving style is correlated with personality traits, especially neuroticism and sensation seeking [9], the relationship between personality traits and preferred driving style in automated vehicles should be a subject of future examinations. Since people high in neuroticism are characterized as anxious and easily distractable, it is likely that these drivers prefer a more defensive driving style as a passenger whereas sensation seekers might prefer the more aggressive style, suiting their need for excitement.

In highly automated cars, non-driving related activities will come into focus [40]. Using Advanced Driver Assistance Systems (ADAS) can be experienced as a reduction of driving enjoyment and fun by some drivers [14], requiring autonomous vehicles to address individual user needs [40]. These activities are likely to be dependent on the driver's or passenger's personality and associated behavior patterns. For example, we can expect that passengers high in

extraversion seek active and energetic activities and appreciate the possibilities to socially interact [26, 39]. Passengers open to new experience, who pursue external stimuli, could be equipped with information about point of interests on the road [24]. In addition, users' preferences for specific app usage, as outlined by Stachl et al., could provide clues for suitable tasks, such as a focus on entertainment and communication applications for extraverted drivers [49].

Limitations and Future Work

Although the influence of personality traits on interacting with automated machines and trust in these systems was outlined in previous research [46], the magnitude and accuracy of these effects are not clear or do not correspond over different studies [37, 46, 5]. There could be several reasons for these findings. A major challenge to examine the potential of personality traits in the design of autonomous vehicles will be adequate methodological approaches for the evaluation. Due to the lack of available autonomous cars in research labs, many findings rely on self report [37]. To find differences between extreme groups of each dimension, a high number of participants is needed, which might also have to be pre-screened. Current findings with only few participants might not be suitable to draw conclusions about personality traits. Although short personality item scales have reasonable reliability and validity, for example used in [6, 37], longer inventories still have higher effect sizes and should thus be considered for future research [41].

When overcoming these challenges, designing for personality in automated machines, especially vehicles, can be a promising approach to increase the individual user's trust and improve human machine interaction.

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