

# The exploration of autonomous vehicle driving styles : preferred longitudinal, lateral, and vertical accelerations

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# The Exploration of Autonomous Vehicle Driving Styles: Preferred Longitudinal, Lateral, and Vertical Accelerations

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## ABSTRACT

This paper describes a new approach in exploring preferred driving styles for autonomous vehicles through simulation of autonomous driving in real road conditions. A Wizard experiment with an equipped car was conducted to investigate the preferences of people with different driving styles, assertive and defensive, for three autonomous vehicle driving styles (defensive, assertive and light rail transit), inducing different acceleration forces, at three different road profiles. Subjective and objective measurements were collected. The results show that the defensive driving style was preferred and there were variations between participants related to their own driving style. The results indicate that the preferences of assertive drivers for the driving style of an autonomous vehicle may not match their own driving style. Yet, users of future autonomous vehicles should be able to indicate and adjust the driving behaviour of an autonomous vehicle to their own preferences in order to maximize comfort in travelling experience.

## Author Keywords

Acceleration; assertive driving style; autonomous vehicle; defensive driving style; light rail transit driving style; sensation seeking

## ACM Classification Keywords

H.1.2. User/Machine System: Human factors; H.5.2 User Interface: Evaluation/methodology.

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## INTRODUCTION

Fully autonomous driving is expected to offer human drivers/users the opportunity to spend more of their travelling time by relaxing, working, or simply enjoying the in-car entertainment system [1]. Hence, future autonomous vehicle (AV) users will likely expect a comfortable riding experience. However, preferences for comfort settings may vary depending on different factors including people's own driving style (DS) [2].

Taubman-Ben-Ari et al. [3] investigated driving styles and arrived at eight types of DSs. They developed the Multidimensional Driving Style Inventory (MDSI) based on data from Israeli drivers. The MDSI was further validated by Hooft van Huysduynen et al. [4] for drivers in Belgium and Netherlands. In addition, Taubman-Ben-Ari et al. [3] found correlations between certain DSs and a sensation seeking (SS) trait, which was assessed using the questionnaire developed by Zuckerman et al. [5]. High SS scores were related to risky and high-velocity DSs while low SS scores were related to careful DS. Based on this finding, high SS drivers tend to be assertive drivers, who like to drive at or above the designated speed limit [6] and like to experience high accelerations during driving. Conversely, low SS drivers can be characterized as defensive drivers, who show less risky driving behaviour.

Whereas human drivers drive their cars based on emotions and motivations [7], [8], an AV is basically a very sophisticated robot maximizing safety, and the way it operates is strictly based on optimized logic. Hence, a conflict may arise in the DS preferences for the different types of AV users such as concerning the selection of accelerations at different road profiles. Thus, in order for AV users to enjoy doing secondary tasks and feeling comfortable, it might be expected that the AV users' preferences have to be matched with the AV DS.

Accordingly, the purpose of this study was to explore preferences of AV users, especially for the selection of the accelerations in three directions (longitudinal, lateral and vertical directions) for two projected autonomous driving

styles (AV DSs), assertive and defensive. In addition, an existing transportation system delivering comfortable ways of travelling is the light rail transit (LRT), a vehicle that typically accelerates and decelerates slower than a human-driven car and provides freedom to the users to perform any secondary task whilst in a journey [9]. Thus, an LRT DS is also considered as a projected autonomous driving style to be explored in this study.

In line with the idea that drivers are primarily comfortable with their own driving styles, it was hypothesized that human drivers with assertive and defensive DSs were expected to be only comfortable with the matching type of DSs in the AV. In addition, both types of human drivers were expected to feel uncomfortable with the LRT AV DS due to the very defensive driving style. The hypotheses are summarized in Table 1.

Human Driver DS		Assertive	Defensive
AV DS			
Assertive		Comfortable	Uncomfortable
Defensive		Uncomfortable	Comfortable
LRT		Uncomfortable	Uncomfortable

Table 1. Hypotheses of AV DSs preferences

**METHODOLOGY**

One of the ways to study human factors in AV experience is to use a driving simulator. Depending on the purpose of the study, a low-cost fixed-base driving simulator may suffice to induce an AV driving experience. However, as mentioned by Reymond and Kemeny [10], an extended study that involves the physical comfort experience related to experiencing acceleration forces in a vehicle, requires at least a moveable-base driving simulator system. However, most driving simulators are developed only for certain requirements and ignore other aspects of reality, which may affect the results [11]. Hence, we chose to execute this study in a real-road context with an equipped car. Instead of using an autonomous vehicle, autonomous driving was simulated through a Wizard approach with a normal car.

**Equipment and Wizard setup**

An Audi A3, a family-sized testing vehicle from the TU/e Automotive Lab, was used for this study. The AV Driving style was simulated by a human driver, the Driving Wizard, who was an experienced driver with a valid driving license. The Driving Wizard was implemented based on the method developed by Baltodano et al. [12]. His main role was to simulate the three projected AV DSs and to induce the corresponding acceleration forces. The AV accelerations simulated by the Driving Wizard must be kept consistent. To this end, a special device, the Automatic Acceleration and Data controller (AUTOAccD), was developed and implemented in the vehicle to provide the Driving Wizard simulating the different AV DSs with continuous real-time feedback about the induced acceleration forces at the desired locations [13]. The AUTOAccD consisted of several electronic components such as accelerometers and

an on-board diagnostic (OBD) adapter. The OBD adapter was coupled to an OBD connector in the vehicle, and a 3.2” LCD display was placed on the windshield (Figure 1), where the Driving Wizard could access the range of acceleration forces on a real-time display. In addition, all the extracted data from the vehicle’s system were retrieved through the OBD and stored in a Secure Digital (SD) card memory located within the AUTOAccD.

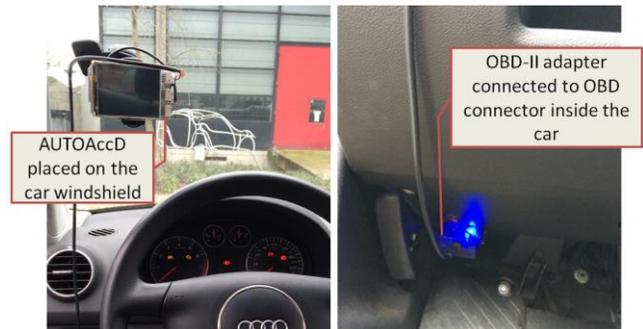


Figure 1. AUTOAccD placement inside the car

A series of training exercises was conducted before the study took place in order to make sure the Driving Wizard was able to maintain the desired accelerations at constant rates. Moreover, two drivers were used in this study and they were trained with AUTOAccD.

In addition, the co-driver, the Interaction Wizard, was in the car to complement the Driving Wizard. The primary role of the Interaction Wizard was to assist participants at any time and handling the questionnaires to participants during the experiment.

**Road Scenarios and Selected Ranges of Accelerations**

The study was conducted on real roads within the TU/e compound. Critical points of interest (POI) were selected to probe participants’ opinions about the simulated AV DSs. POI A is a speed hump, where the vertical acceleration was simulated. Longitudinal acceleration and deceleration were simulated on a straight road leaving or approaching a junction, at POI B and POI C, respectively. POI D was located on a curve road, to simulate lateral acceleration. The total length of the track was around 440 meters.

Based on previous findings [9], [14]–[18], ranges of longitudinal, lateral, and vertical accelerations for assertive and defensive AV DS, either maximum rates or average accelerations over a distance or time, were defined in term of gravitational acceleration (g) as shown in Table 2. There was no vertical acceleration range for the LRT because it does not induce notable vertical forces.

**Participants**

Twelve healthy participants (7 male and 5 female) who owned valid driving licenses participated voluntarily in this study. They were all employees or students at the Eindhoven University of Technology (TU/e) and aged between 24 to 39 year old (Mean = 29.6, SD = 4.0). Before

participating, they answered the SS [5] questionnaire. On the basis of the SS questionnaire's score, they were classified as assertive (6 participants) or defensive (6 participants) drivers. Drivers with high SS scores (between 10 and 19) were considered as assertive drivers, while drivers with low SS scores (between 0 and 9) were considered as defensive drivers.

Type of Acceleration	LRT AV DS	Defensive AV DS	Assertive AV DS
Longitudinal Acceleration	0.00 g to 0.14 g	0.14 g to 0.25 g	0.25 g to 0.50 g
Longitudinal Deceleration	0.00 g to -0.14 g	-0.14 g to -0.33 g	-0.33 g to -0.76 g
Lateral Acceleration	0.00 g to 0.15 g	0.15 g to 0.42 g	0.42 g to 0.54 g
Vertical Acceleration	-	0.00 g to 0.16 g	0.16 g to 0.66 g

**Table 2. Ranges of accelerations for LRT, defensive, and assertive AV DSs in triaxial directions**

**Ratings**

In total, five different rating scales, labelled as R1, R2, R3, R4, and R5, were used in this study to elicit the participants' opinion at each of the POI. R1, R2, and R3 asked for judgements about the driving behaviour in terms of comfort, pleasantness, and safety, respectively. R4 was used to check the comparison between the simulated AV DS and the participant's DS while R5 asked for judgments about the magnitude of the acceleration. All items consisted of five-point Likert scales with R1 1 = 'very comfortable' and 5 = 'very uncomfortable', R2 1 = 'very pleasant' and 5 = 'very unpleasant', R3 1 = 'very safe' and 5 = 'very dangerous', R4 1 = 'very true of me' and 5 = 'very untrue of me', and R5 1 = 'the force is much too high' and 5 = 'the force is much too low'.

**Procedure**

Upon arrival, the participant was briefed about the nature of the experiment, especially the role of the participant during the experiment and was asked to sign the consent form. Then, the participant was brought to the car and once the participant was seated in the back seat, reminders of the safety measures such as fasten the seatbelt were given by the Interactive Wizard.

Then the Driving Wizard drove the car to the first POI, POI A. Just before arriving at the POI A, the car was stopped and the Interactive Wizard gave a short briefing to the participant about the induced force to be generated from the acceleration when the vehicle was passing through POI A. Then, the Driving Wizard simulated the AV DS according to the selected acceleration based on Table 2. Next, once the AV DS had been simulated, the car was stopped again, and the Interactive Wizard handed out the rating form to the participant. The participants gave the ratings directly after experiencing the force, in order to minimize the washout effects [19]. In addition, the car needed to be in a standstill

position when the participants were engaged in the rating task to reduce any carsickness symptoms [20]. After the participant completed the ratings for the current POI, the Driving Wizard drove the car to the next POI. This sequence was repeated at POI B, C and D.

To balance carry-over effects, the order of simulated AV DSs was pseudo-randomized for all participants, so that all orders occurred equally often. Within a ride, always the same DS was presented. After all the three types of AV DSs had been simulated, the participant was brought back to the starting point for a short debriefing and was given a small voucher as a token of appreciation. The total length of the scenario was around 45 minutes.

**RESULTS AND DISCUSSIONS**

**Phase 1: Comfort, Pleasantness and Safety Ratings (R1, R2 and R3)**

The Wilcoxon signed-ranks test (WSRT), a non-parametric analysis, was carried out to find the relations between the ratings for the two simulated AV DSs at POI A (Table 3). The Friedman's Test (FT) was used to compare the ratings for the three simulated AV DS at POI B, C, and D. If there was a significant result from FT, post-hoc analyses with WSRT were conducted with a Bonferroni correction applied, setting  $p_{crit} < 0.017$  [21].

The results for POI A (speed hump), POI B (acceleration), POI C (deceleration), and POI D (cornering) are shown in Table 3, Table 4, Table 5, and Table 6, respectively. Each table consists of ratings (R) for comfort, pleasantness and safety, type of driver (Dri), the median rating (Mdn) as the measure of central tendency, and the results of the statistical test.

*Point of Interest (POI) A - Speed Hump*

As can be seen in Table 3, the test showed that for assertive drivers, the ratings for comfort, pleasantness and safety were significantly higher for defensive AV DS than for assertive AV DS. The same result was found for defensive drivers.

R	Dri	AV DS	Mdn	WSRT
1. Comfort	A	A	3.0	$z = -2.03, p = 0.042^*$
		D	1.0	$r = -0.59$
	D	A	4.0	$z = -2.23, p = 0.026^*$
		D	1.5	$r = -0.64$
2. Pleasantness	A	A	4.0	$z = -2.23, p = 0.026^*$
		D	1.0	$r = -0.64$
	D	A	3.5	$z = -2.23, p = 0.026^*$
		D	2.0	$r = -0.64$
3. Safety	A	A	2.5	$z = -2.07, p = 0.038^*$
		D	1.0	$r = -0.60$
	D	A	4.0	$z = -2.27, p = 0.023^*$
		D	1.0	$r = -0.66$

\* Indicates significant effect ( $p < .05$ )

**Table 3. Rating analysis at POI A (speed hump)**

In general, both types of drivers indicated higher comfort, pleasantness and safety for the simulated defensive AV DS

at POI A (Mdn = 1.0 to 2.0). Furthermore, as expected, defensive drivers were more negative towards the simulated assertive AV DS (Mdn rating 3.5 to 4.0) than assertive drivers (Mdn rating 2.5 to 4.0). Finally, although assertive drivers were neutral about the comfort and safety of the assertive AV DS, they rated the assertive AV DS to be unpleasant (Mdn = 4.0).

**Point of Interest (POI) B - Acceleration**

Table 4 shows that, for assertive drivers, the ratings for comfort, pleasantness and safety were lower (indicating better appreciation) for defensive and LRT AV DS than for assertive AV DS, but none of the comparisons gave a significant effect. The same direction of judgements (better appreciation of defensive and LRT AV DS) was obtained from defensive drivers; here, most comparisons were significant.

	R	Dri	AV DS	Mdn	FT	WSRT	
1. Comfort	A	A	A	4.0	$\chi^2(2) = 2.22,$ $p = 0.331$	-	
			D	3.0			
			LRT	2.5			
	D	D	A	4.0	$\chi^2(2) = 10.18,$ $p = 0.006^{**}$	A	$z = -2.22, p = 0.016^*,$ $r = -0.64$
			D	2.0		A	$z = -2.21, p = 0.016^*,$ $r = -0.64$
			LRT	2.0		D	$z = -0.38, p = 0.500,$ $r = -0.11$
2. Pleasantness	A	A	A	4.0	$\chi^2(2) = 4.10,$ $p = 0.129$	-	
			D	1.5			
			LRT	2.5			
	D	D	A	4.0	$\chi^2(2) = 10.38,$ $p = 0.006^{**}$	A	$z = -2.23, p = 0.016^*,$ $r = -0.64$
			D	2.0		A	$z = -2.26, p = 0.016^*,$ $r = -0.65$
			LRT	2.0		D	$z = -0.58, p = 0.375,$ $r = -0.17$
3. Safety	A	A	A	3.5	$\chi^2(2) = 4.57,$ $p = 0.102$	-	
			D	2.0			
			LRT	1.5			
	D	D	A	4.0	$\chi^2(2) = 10.17,$ $p = 0.006^{**}$	A	$z = -2.26, p = 0.016^*,$ $r = -0.65$
			D	2.0		A	$z = -2.25, p = 0.016^*,$ $r = -0.65$
			LRT	1.5		D	$z = -1.34, p = 0.188,$ $r = -0.39$

\* Indicates significant effect ( $p < .017$ )  
 \*\* Indicates highly significant effect ( $p < .01$  with  $p_{crit} < .05$ )

**Table 4. Ratings analysis at POI B (acceleration)**

**Point of Interest (POI) C - Deceleration**

As can be seen from Table 5, AV DS had a significant effect (shown in column FT) in all cases. Again, the pattern was the same, with better appreciation of defensive and LRT AV DS, both for participants with an assertive and a defensive driving style, but due to the Bonferroni adjustment of  $p_{crit}$  for multiple comparisons only few post-hoc tests gave significant results. In general, both types of drivers indicated uncomfortable, unpleasant and unsafe feelings with assertive AV DS for the braking scenario. On the other hand, both types of drivers showed comfortable, pleasant and safe feelings with defensive and LRT AV DSs.

	R	Dri	AV DS	Mdn	FT	WSRT	
1. Comfort	A	A	A	4.0	$\chi^2(2) = 8.27,$ $p = 0.016^*$	A	$z = -2.22, p = 0.016^*,$ $r = -0.64$
			D	2.0		A	$z = -2.12, p = 0.031,$ $r = -0.61$
			LRT	1.0		D	$z = -0.28, p = 0.500,$ $r = -0.08$
	D	D	A	4.0	$\chi^2(2) = 6.10,$ $p = 0.047^*$	A	$z = -2.07, p = 0.031,$ $r = -0.60$
			D	2.0		A	$z = -1.83, p = 0.063,$ $r = -0.53$
			LRT	2.0		D	$z = -0.41, p = 0.406,$ $r = -0.12$
2. Pleasantness	A	A	A	4.0	$\chi^2(2) = 7.18,$ $p = 0.028^*$	A	$z = -2.12, p = 0.031,$ $r = -0.61$
			D	3.0		A	$z = -2.06, p = 0.031,$ $r = -0.59$
			LRT	1.0		D	$z = -1.22, p = 0.188,$ $r = -0.35$
	D	D	A	4.0	$\chi^2(2) = 8.40,$ $p = 0.015^*$	A	$z = -2.00, p = 0.063,$ $r = -0.58$
			D	2.0		A	$z = -2.32, p = 0.016^*,$ $r = -0.64$
			LRT	2.0		D	$z = -1.13, p = 0.250,$ $r = -0.33$
3. Safety	A	A	A	3.5	$\chi^2(2) = 10.30,$ $p = 0.006^{**}$	A	$z = -2.04, p = 0.031,$ $r = -0.59$
			D	2.0		A	$z = -2.23, p = 0.016^*,$ $r = -0.64$
			LRT	1.0		D	$z = -1.73, p = 0.125,$ $r = -0.50$
	D	D	A	3.5	$\chi^2(2) = 6.91,$ $p = 0.032^*$	A	$z = -2.27, p = 0.016^*,$ $r = -0.58$
			D	2.0		A	$z = -1.84, p = 0.063,$ $r = -0.53$
			LRT	2.0		D	$z = -0.33, p = 0.500,$ $r = -0.10$

\* Indicates significant effect ( $p < .017$ )  
 \*\* Indicates highly significant effect ( $p < .01$  with  $p_{crit} < .05$ )

**Table 5. Ratings analysis at POI C (deceleration)**

**Point of Interest (POI) D - Cornering**

As can be seen from Table 6, for POI D the same trend emerged as for the other POIs, with better appreciation of defensive and LRT AV DS than of assertive AV DS, although the differences in ratings were smaller. However, the ratings for the assertive AV DS in general were less negative than for the other POIs. The effect of AV DS was significant for ratings of comfort and safety, both for assertive and defensive drivers, but not for ratings of pleasantness. Post-hoc analyses showed that, both for assertive and defensive drivers, the differences between assertive and defensive AV DSs and between assertive and LRT AV DSs were significant for comfort ratings. For safety ratings, again due to the Bonferroni adjustment of  $p_{crit}$  for multiple comparisons only few post-hoc tests gave significant results.

	R	Dri	AV DS	Mdn	FT	WSRT	
1. Comfort	A	A	A	3.5	$\chi^2(2) = 10.18,$ $p = 0.006^{**}$	A	$z = -2.33, p = 0.016^*,$ $r = -0.67$
			D	1.5		A	$z = -2.23, p = 0.016^*,$ $r = -0.64$
			LRT	1.0		D	$z = -1.00, p = 0.312,$ $r = -0.29$

	A	3.0		A	$z = -2.07, p = 0.031^*$ , $r = -0.60$
	D	2.0	$\chi^2(2) = 10.30,$ $p = 0.006^{***}$	D	$z = -2.27, p = 0.016^*$ , $r = -0.66$
	LRT	2.0		LRT	$z = -1.73, p = 0.125,$ $r = -0.50$
2. Pleasantness	A	3.0	$\chi^2(2) = 4.67,$ $p = 0.097$	A	-
	D	2.0		D	-
	LRT	2.0		LRT	-
3. Safety	A	2.5	$\chi^2(2) = 7.63,$ $p = 0.022^*$	A	$z = -2.06, p = 0.031,$ $r = -0.59$
	D	2.0		D	$z = -1.84, p = 0.063,$ $r = -0.64$
	LRT	2.0		LRT	$z = -0.00, p = 0.750,$ $r = -0.00$
	A	3.0	$\chi^2(2) = 10.30,$ $p = 0.006^*$	A	$z = -2.07, p = 0.031,$ $r = 0.60$
	D	2.0		D	$z = -2.23, p = 0.016^*,$ $r = -0.64$
	LRT	1.5		LRT	$z = -1.73, p = 0.125,$ $r = -0.50$

\* Indicates significant effect ( $p < .017$ )  
 \*\*\* Indicates highly significant effect ( $p < .01$  with  $p_{crit} < .05$ )

Table 6. Ratings analysis at POI D (cornering)

Phase 2: Range Refinement (R4 and R5)

Figure 2 shows participants' self-reflections on their own DS when compared to the simulated AV DSs (R4) and participants' opinion on the magnitude of the simulated AV DSs (R5). Participants no. 1 to 6 were assertive drivers and participants no. 7 to 12 were defensive drivers. In addition, Figure 2 was arranged in such a way that it started with the highest SS score to the lowest SS score, in which participant no.1 was the driver with the highest SS score while participant no.12 was the driver with the lowest SS score.

A general trend that can be deduced from this figure is that most of the participants agreed with the defensive AV DS settings. In addition, most participants found the LRT AV DS too defensive and the assertive AV DS too assertive.

Looking at the results in more detail, for longitudinal acceleration, nearly all participants reported that the simulated assertive AV DS was too aggressive. On the other hand, most participants felt the simulated defensive AV DS was just right and half of participants indicated that the simulated LRT AV DS was too defensive. In addition, participants reported to have different opinions about the simulated AV DS depending on whether they were driver

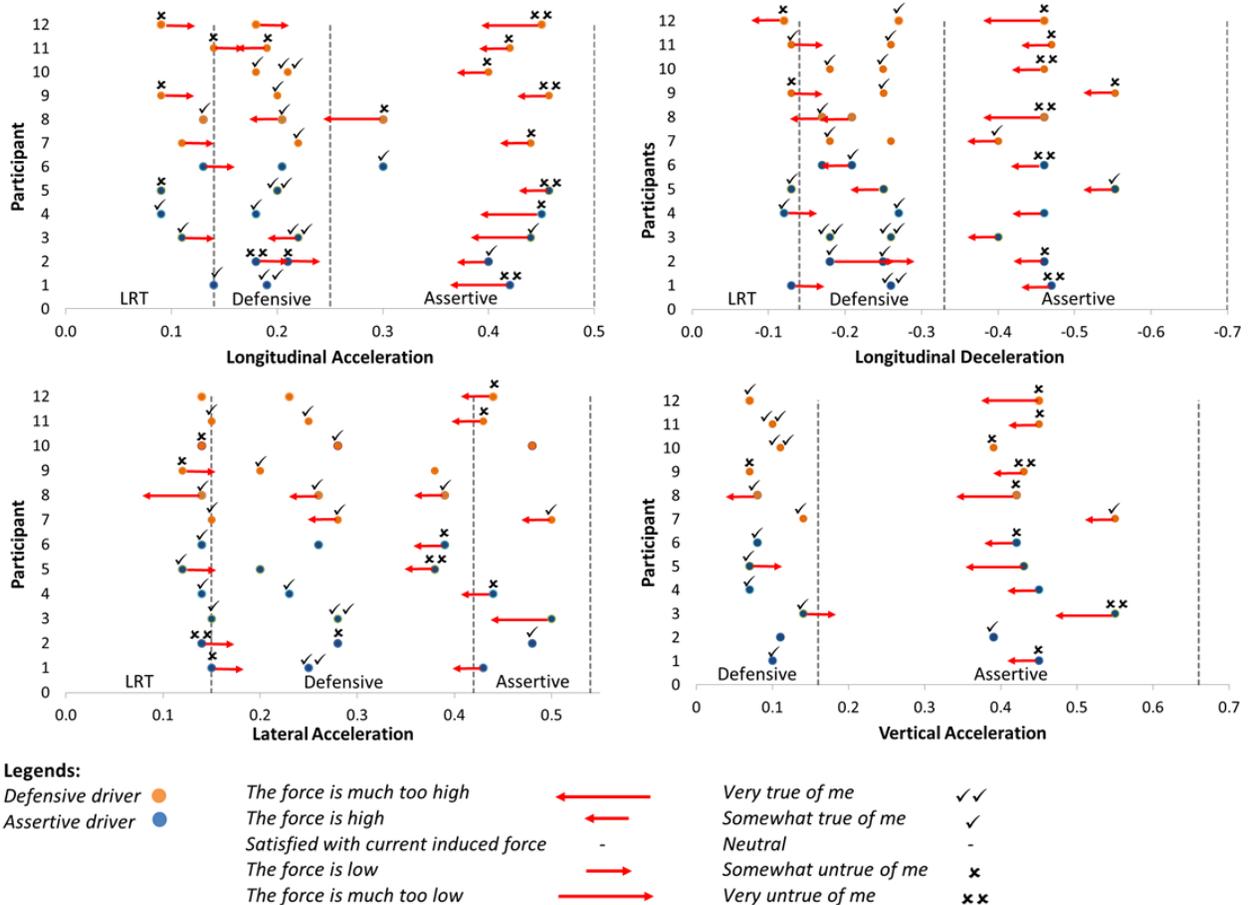


Figure 2. Comparison of AV DSs with participant perception, and reflection of own DS with the AV DS. Participants no. 1 to 6 are assertive drivers and participants no. 7 to 12 are defensive drivers.

or passenger. For example, participants no. 2 and 3 stated that the acceleration for assertive AV DS was similar to their actual DS, but as a passenger (as in this study) they believed that the induced forces (forces generated by the acceleration) should be lowered. Only participant no. 8 preferred the LRT AV DS while participant no. 2 can be considered as an extremely assertive driver as he/she indicated that the acceleration forces should be higher than the ones that were presented in this study.

A similar trend was found for simulated longitudinal deceleration. All participants indicated that the simulated assertive AV DS was too assertive. The majority of the participants indicated that the defensive and LRT AV DSs were similar to their preferences. However, it should be noted that the simulated LRT AV DS was conducted nearly at the lower-end of the defensive AV DS's range because of the difficulties to simulate such small accelerations in a relatively short track available in the compound of TU/e. Furthermore, most participants reflected that their own DS was similar to the simulated defensive AV DS, with an exception to participant no. 8, who showed a preference for the LRT AV DS when decelerating.

For lateral acceleration or cornering, most participants judged that the simulated assertive AV DS were too intense (some were simulated at the higher-end of defensive AV DS's range). Most participants indicated that the simulated defensive AV DS was just right while half of participants mentioned that the simulated LRT AV DS was too defensive. It should be noted that due to experimental difficulties, almost all simulated LRT AV DS were simulated at the lower-end of the defensive AV DS's range. In addition, most of the participants (except for participant no. 2 and 7) showed that the simulated defensive or LRT AV DSs were a reflection of their own DSs. Once more, participant no. 8 demonstrated strong preference towards the LRT AV DS in the cornering.

For vertical acceleration, two participants (no. 2 and 10) were satisfied with the simulated assertive AV DS while most participants thought that the simulated defensive AV DS was just right. In addition, the majority of the participants indicated that the simulated defensive AV DS were almost the same as their own DSs. Only two participants (no. 2 and 7) revealed that the simulated assertive AV DS were about the same as their own DS.

In general, most participants with a defensive driving style agreed that the simulated defensive AV DS was somewhat similar to their own driving styles. Therefore, it was no surprise that they indicated that the simulated assertive AV DS should be slower. Interestingly, some participants with an assertive driving style stated that the simulated defensive AV DS was a good reflection of their own driving styles. They also pointed out that the forces felt in simulated assertive AV DSs should be lowered.

## CONCLUSIONS AND GENERAL DISCUSSION

The present work explored the experienced comfort, pleasantness and safety of three different simulated driving styles for autonomous vehicles for two types of drivers. The simulated AV DSs were assertive, defensive and LRT AV DSs, and were simulated at different locations in real road conditions to induce triaxial accelerations (longitudinal, lateral and vertical accelerations). In order to achieve the predefined accelerations, a Wizard approach was used with support from a device called AUTOAccD. Assertive and defensive drivers were identified by means of a questionnaire on the Sensation Seeking dimension developed by Zuckerman et al. [5].

The subjective ratings show a consistent pattern. Both types of drivers rated the comfort, pleasantness and safety of the defensive and LRT AV DS higher than of the assertive AV DS. The associated comparisons were not always significant, since the use of Bonferroni correction makes the test a bit conservative ( $p_{crit} < 0.017$ ). If such strict correction had not been applied, the results would otherwise show significant differences between assertive and defensive AV DSs, and between assertive and LRT AV DSs.

In general, the responses of both types of participants in the current study were rather similar regarding the self-reflection (R4) and simulated accelerations (R5) ratings. Only participant no. 2, an assertive driver, demonstrated a preference for high acceleration forces during the experiment. Conversely, participant no. 8, a defensive driver, reported that the LRT AV DS was better than the defensive AV DS. Regardless of driver' type, participants pointed out that they would prefer all generated forces to be in the range of defensive and LRT AV DSs. Hence, in the current study, there are no notable differences between assertive and defensive drivers. While it was found before that Sensation Seeking and acceleration are highly correlated when people drive themselves [22], the current finding contradict our hypothesis that people prefer a driving style for an autonomous vehicle that matches their own driving style.

In this respect, it is worthwhile to note that Hooft van Huysduynen et al. [4] mention that Driving style may vary with the context. We may well imagine that an assertive driver will have different requirements and preferences when being driven by an autonomous vehicle than when driving himself.

An alternative explanation is that the predefined range of accelerations in the assertive AV DS may have been too high (especially for vertical acceleration and both longitudinal acceleration and deceleration). If the selected assertive AV DS would have been less extreme than what they were in this study, assertive drivers might have appreciated the simulated assertive AV DS more than the defensive AV DS.

Finally, a note on the applied method. The use of a Wizard approach has the disadvantage that there is variation in the realized forces, so that participants did not always receive exactly the same forces. However, through the use of the AutoAccD device the realized forces could be kept mostly in the intended range. In addition, the advantage of the Wizard approach is that autonomous driving can be simulated in real road conditions, allowing us to address questions that could otherwise be addressed only in driving simulators or after an autonomous vehicle has become available.

In summary, both types of drivers preferred the defensive and LRT AV DSs, although it cannot be ruled out that the ranges for the assertive AV DS was not adequately defined. The finding that the AV DS does not match the self-driven DS may be related to the possibility that driving style also depends on the context and motive [8] of why one is driving or travelling. For instance, in some situations users of autonomous vehicles may choose a more comfortable setting as they wish to utilize their time for secondary/non-driving tasks inside the AV, while in other situations they may select the assertive AV DS when they want to have a thrilling driving experience or are late for a meeting or an interview, and are willing to sacrifice physical comfort. To enable users to make the driving style dependent on the situation, a user interface to select the preferred acceleration as shown in Figure 3 may be developed in order to maximize the experiences in riding an AV in the near future. Further studies should be conducted to investigate the preferred ranges of acceleration in different contexts or in different situations, such as the use of secondary tasks inside the AV.

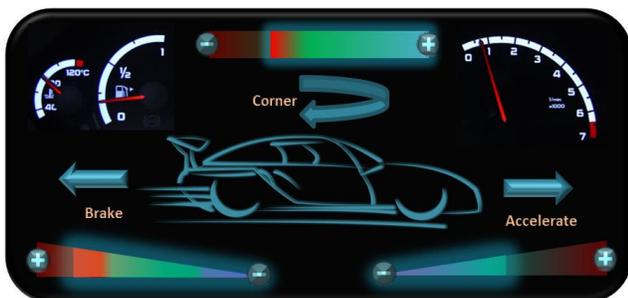


Figure 3. Example of user interface for preferred AV DSs selection

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