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Findings of Test-Drive and On-Line Survey Study

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ABSTRACT

Freeways form an important part of the road network. Drivers' behavior can be split in longitudinal (acceleration and deceleration) and lateral behavior (lane changing). The combination of these two behaviors on freeways play a key role in traffic operations. This paper tries to describe the driving behavior, emphasizing the relation between the lateral and longitudinal behavior. To this end, an experimental study based on a test-drive and on-line questionnaire has been carried out. For the test-drive, 34 participants drove a vehicle equipped with monitoring systems. Based on the test drives a survey was developed regarding driving behavior in specific situations. This survey was answered by 1258 drivers who were questioned using videos for specific and relevant situations. The results show that most people choose a speed first, and stick to that. Fewer people adapt a strategy of having a desired speed which might change when they are in a different lane to overtake, or a strategy to choose a desired lane, and tries to adapt speed. A small fraction of the respondents mentioned that they have neither a desired speed or a desired lane. Most people (80%) use the right lane if possible, and 80% will not overtake at the right. 70% may have a courtesy behavior when needed. The outcome of this study has shed some light on the naturalistic driving behavior on freeways under different situations. The findings of this work can be implemented in traffic simulation programs, which are able to delay with this scale of traffic behavior. Repeating this survey in international context will reveal differences between drivers in various countries.

1 INTRODUCTION

Freeway roads constitute a principal part of the transport infrastructures. Increasing car ownership and limitations in extending the infrastructure have led to congested traffic conditions on road networks. Maintaining a steady speed in a congested traffic regime on freeways is extremely difficult, since frequent acceleration-deceleration has been observed often in the so called stop-and-go traffic during congestion periods. Moreover, drivers may execute lane change maneuvers either to improve their driving comfort (discretionary lane changes; DLC) or to follow their path to reach a destination (mandatory lane change; MLC). Recent studies revealed that lane changes cause disruptions and oscillations (1) and consequently might influence the capacity of the road by leaving voids (2). The traffic oscillation caused by the lateral and/or longitudinal driving behavior (lane change and car-following, respectively) may result in a range of problems including safety hazards, extra fuel consumption, emissions, delays, and driver discomfort. To mitigate the adverse impact of the aforementioned oscillations and instability on freeway traffic operations, a better understanding of traffic dynamics is an important prerequisite. An accurate microscopic simulator allows traffic experts to model a complex traffic situation realistically and to assess various traffic management alternatives in order to determine a proper solution for the aforementioned problems. Existing models on lane changing behavior typically differentiate DLC and MLC and consequently develop different models for these two lane chaning behaviors separately. For instance, some models focus on DLC typically and lack a MLC component (2) and vice versa (3). An integrated lane change model where mandatory and discretionary conditions joined together in a single utility model has been proposed in (4).

In order to quantify the complex features of multi-lane traffic, understanding the lane change behavior on freeways is essential. As addressed in (5) and (6), modeling lane changing maneuvers is a key component of microscopic traffic simulation tools. Several studies have been carried out on developing realistic lane change models. However, despite its extreme importance in mimicking traffic operations on freeways, among the researchers it did not attain as much attention as the car-following models (for a review see (7) and (8)). Rule-based and discrete-choice-based models are the most popular microscopic lane changing algorithms in literature (9). In rule-based models, considering the heterogeneity among drivers, different gap acceptance conditions have been taken into account. It was argued that oscillations are the result of driver heterogeneous reactions to deceleration waves on freeways (10). Many lane changing models incorporate the heterogeneity of drivers by different parameter sets. For the car-following behavior, it has been shown that different drivers drive differently (11). A recent study (12) confirmed that various drivers have completely different strategies to choose lanes and that the choices to change lane are related to their speed choice. This shows that considering different parameter sets may not be a reliable approach to model heterogeneous driving behavior in a microscopic simulation environment. The more detailed discrete-choice-based algorithms apply logit models to simulate driver behavior (13). This group of microscopic algorithms can describe lane changing behavior in detail, but they often contain a large number of parameters which makes it hard to calibrate and validate the model (6). The recently developed LMRS model (14) combines the route, speed and *keep right* incentives and influences the car-following behavior for relaxation and synchronization.

In none of the aforementioned lane change models, the incentives and reasoning of the drivers to change lanes have been taken into account. Only by asking people, a better insight and understanding of the intrinsic motivations for their driving behavior can be obtained. To do that,

focus group discussions were used to study merging behavior at freeways (15). Participants had to discuss and indicate their thinking process during a merging maneuver from an on-ramp to a freeway. Several other studies utilized questionnaires to investigate different aspects of driving behavior, for example in (16) and (17). In (18) the driving behavior at merging areas was studied using an instrumented vehicle. In this case the drivers commented in real-time on their behavior and were aware of their actions. However, this may lead to a driving behavior which might not reflect reality properly. Other works apply driving simulators to study the driving behavior (19). A potential disadvantage of driving simulators could be that they only provide a representation of reality, not reality itself. However, driving simulators are attractive to researchers, since they can be used to create a goal-oriented virtual world for implementing different scenarios which might not be tested easily in the real world.

Using an instrumented car (12) combined an interview-based study with a test-drive. Four distinct lane change strategies for DLC behaviour were unveiled: *Speed Leading*; *Speed Leading with Overtaking*; *Lane Leading* and *Traffic Leading*. Simulating the four lane change strategies led to different traffic operation characteristics (20). In particular, it has been observed that the capacity, instability occurrence, lane change rate and lane flow distribution might be affected by different lane change strategies. This confirms the importance of the derivation of a realistic flow distribution over the different strategies for developing an accurate lane change model.

The work described in this paper is a follow-up of (12) and investigates the factors which might affect the distribution of drivers over the forenamed lane change strategies. To this end, a three-stage study has been carried out. First, 34 people were asked to drive a camera-equipped car on a predefined route of about 40 kilometers in the vicinity of Delft, the Netherlands. Right after the test-drive, the drivers were interviewed and some background information was asked via a questionnaire. Due to practical reasons, the number of participants and the duration of the field experiment was limited. Thus, as a complementary tool, the driving experiment was followed with an on-line survey. The video recordings from the test-drives were used in this on-line survey. To the best of our knowledge, none of the existing studies in literature has applied a survey, to ask people about their actions concerning speed and lane choice, by means of video clips of particular traffic situations. The outcome of this work is indeed a step forward in quantifying the application of the four strategies by the drivers on freeways and consequently implementing the developed lane change model in microscopic simulation packages more realistically.

The paper is structured as follows. Section 2 indicates some basic driving regulations and their enforcement on the freeways. In section 3, a brief review of the lane change strategies found in (12) is given. The research approach is presented in section 4. The experimental setup and findings for the test-drive and the survey study is discussed in sections 5 and 6, respectively. Finally, conclusion and further discussions are addressed in section 7.

2 DRIVING REGULATIONS AND ENFORCEMENT

In fact, the driving regulations and their enforcement may affect the behavior of the drivers on freeways. Generally, two types of behavioral regulations are being implemented on freeways. The first regulation is *keep right unless overtaking*, where drivers are forced to keep right whenever possible, and only in case they want to overtake, they change lanes and move back to the right lane afterwards. Consequently, the further left lanes have a higher speed (since they are basically used

by drivers who are overtaking). In congested conditions, this regulation is dropped and drivers might overtake at both sides, sometimes called "synchronized flow" (21), or "one pipe regime" (22). This system is mainly applied in Europe, whereas the United Kingdom and Ireland have a similar system, but drive at the other side; hence it is called *keep left unless overtaking*. The second regulation is *keep your lane* system which is applied in some parts of the USA. Drivers can choose their speed and a lane and are urged to keep that lane, but are not required to go to the rightmost lane. Moreover, overtaking is allowed at either side.

Apart from the regulations, also the enforcement plays an important role. There could be strict enforcement on keeping the right lane if not overtaking, on not overtaking at the left, or on the speed. In a system of *keep right unless overtaking*, generally there will be a relationship between the (enforced) speed and the lane flow distribution. In (23) it is shown that a lower speed limit will increase the fraction of people in the right lane, possibly due to limited overtaking desire. This effect is even stronger if there is enforcement on the *average speed*, in which case drivers do not dare to drive faster, and stick to the right lanes (24).

3 DRIVING STRATEGIES

As mentioned before, the study described in (12) has led to a categorization of the lane change decision process (i.e. strategies), based on a test-drive with 10 participants. Particularly, it has been revealed that the people drive on the freeway according to the following four strategies:

1. *Speed leading:* drivers choose a desired speed for driving on a freeway stretch, and try to stick to that speed as much as possible. If required, they change lanes and overtake to continue driving their speed. Also during the overtaking maneuver, they stick to their desired speed.

2. *Speed leading with overtaking:* as the previous strategy, drivers choose a desired speed and try to maintain that speed as much as possible. They may change lanes to overtake a slower driver. Different from the speed leading strategy, the drivers increase speed when they are overtaking and do not stick to the original desired speed.

3. *Lane leading:* drivers choose a specific lane, and adapt their speed to the speed of that lane, but within margins (typical variations are approximately 40 km/h).

4. *Traffic leading:* drivers neither have a specific lane, nor a desired speed in mind, and "go with the flow".

These strategies were found based on the drivers' behavior on Dutch freeways, hence some of the drivers do not apply the *keep right unless overtaking* regulation. Surprising result from that study was that drivers follow different strategies (whereas all consider themselves "normal drivers"), and that the driving strategies were so divers. This triggered two questions: 1) will a wider group survey reveal more driving strategies and 2) what is the distribution of drivers over the various strategies?

4 RESEARCH APPROACH

The research objective is to get an overview of the driving strategies applied on freeways and obtain the distribution of drivers over those strategies. To this end, a combination of three different methods has been utilized.

First, a focus group of participants took part in test-drives in an instrumented vehicle. The whole period of the test has been recorded using three different cameras: a front-facing and a rear-facing camera for monitoring the surroundings, and an internal camera which recorded the driver. Besides that, the vehicle was equipped with a high-resolution GPS (25) allowing to track the precise location (lane-specific) and the speed of the vehicle. The participants were asked to drive as they normally would drive on a pre-specified route.

Second, the same group of drivers has been interviewed right after the test-drive. During the interviews, the video recorded from the test-drive of each individual was reviewed with the corresponding participant. Moreover, drivers were requested to comment on their motivations for their actions during the test-drive, and faced with hypothetical situations.

Third, the movies from the test-drives were utilized to introduce various questions in the on-line survey. Typical situations were reconstructed in an approximately ten-second movie. Respondents were asked how they would cope with the situation which were shown in the short movie. Generally, that could involve a speed and/or a lane adaptation.

Sections 5 and 6 discuss the experimental setups and the corresponding findings for the test-drive and survey study, respectively.

5 TEST-DRIVE

5.1 Setup

For the test-drives and interviews, participants were recruited using the personal and professional networks of the researchers involved. The professional networks included people from the university, the road authority (Rijkswaterstaat) and the local gardening center (part-time job of the student). These networks were employed as the base starting point, leading to a wider variety of participants. As a compensation for their contribution, all participants received a 25 euro gift card. In total 34 people were recruited, of which 8 female participants. The age distribution is shown in Figure 1.

The test-drives were conducted for 7 days, between 1 and 10 February 2016 with a variety in weather conditions. Most test-drives were performed between 10 AM and 16 PM, i.e. off-peak and in daylight conditions. Some tests were carried out in the evening peak, with higher traffic loads, and under night-time driving conditions.

The test-bed is depicted in Figure 5.1 and consists of various freeways stretches. The 40 km route includes the A13, A20, and A4 in the east, south and north respectively. The freeways have different speed limits, various number of lanes and speed enforcement (i.e. by police patrol, speed cameras and average speed check). Most participants come from the area and are familiar with the main freeways. A part of the route (the A4 stretch) was opened less than a month before the test-drives, which means most participants were unfamiliar with that road stretch. Ideally, people with different levels of route familiarity would be needed for the test-drive.

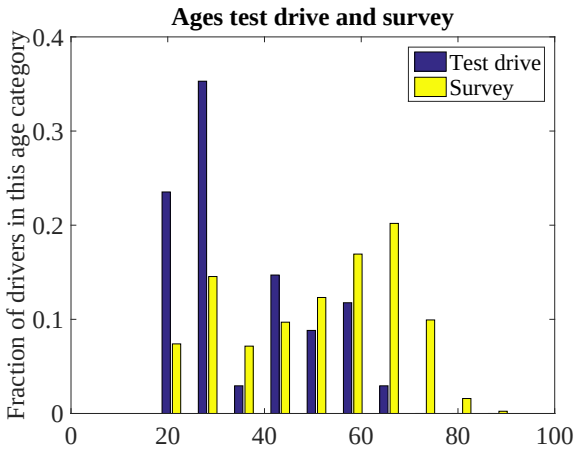


FIGURE 1 Age distribution of the participants: the test-drive vs. the survey

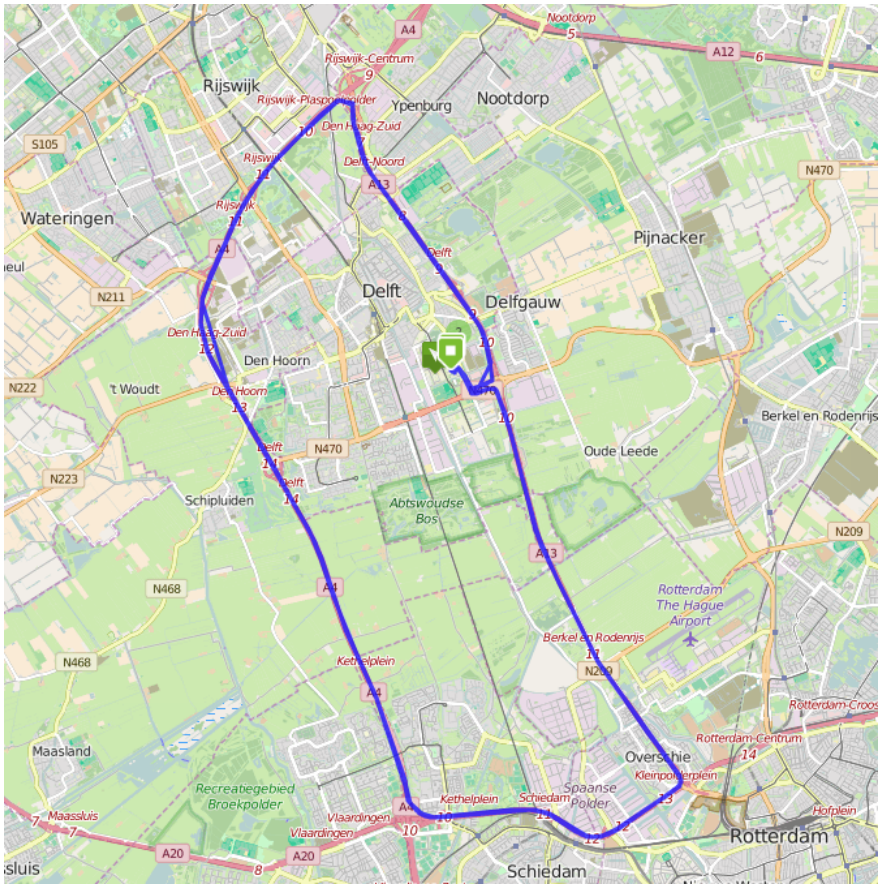


FIGURE 2 Route for test-drive

(a) Raw footage from the test-drive (b) Modified and used for the survey

FIGURE 3 Characteristics of the test-drive

Before the test-drive, drivers were instructed on the use of the vehicle. The instrumentation of the car was not intrusive, or in any way limiting the operation of the car. The car was equipped with an automatic gearbox (less common in the Netherlands than a manual gearbox). The drivers were informed about the route, and, in addition to that, a hand-held navigation device was programmed to guide them. The drivers were instructed to drive safely and to drive as they normally would. During the test-drive, nobody was accompanying the participants.

5.2 Interviews

The aim of the test-drive was to get more insight into the lane change strategy choices of drivers on freeways. An interview is a useful method to get the personal thoughts and opinion from the participants concerning their driving style. So after the participants returned from driving the route, the participants were interviewed. This interview was semi-structured and consisted of two parts: one general part related to the driving style and another part concerning their test-drive. During the interviews, the strategies were discussed with the test-takers. Drivers were asked which strategies they have been applying throughout the trip.

5.3 Results

Figure 4a shows the quoted desired speeds of the participants on the 100 km/h section. Some drivers answered a speed range, whereas others stated one specific value. For the figure, we added a 3.75 km/h margin (positive and negative), accounting for time fluctuations in their speed and deviations in the speedometer. If this were omitted, the figure would have some spikes. The desired speed is approximately 5-10 km/h above the speed limit.

During most test-drives, the road was relatively quiet, thus free speeds could be driven. The impact of familiarity with the road could not be observed. This was concluded while watching the test-drive video recordings with the participant. Table 1 indicates which strategy the drivers applied. This does not indicate for which fraction of the time they applied a certain strategy. Strategy 1 and 2 are most often chosen, and strategy 3 and 4 less often. The initial answer was not always the right answer: further discussion often revealed that drivers used a different strategy than they initially were thinking. Especially, the divers were not always aware of applying strategy 2, but after watching the video, they would sometimes realize that they had indeed a speed increase.

TABLE 1 Distribution of strategies during the test drive

Number of strategies	Speed leading	Speed leading with speed increase when overtaking	Lane leading	Traffic leading	Number of participants	Number of participants
1	x				1	2 (6%)
		x			1	
2	x		x		2	10 (29%)
	x			x	1	
	x	x			4	
		x		x	1	
		x	x		2	
3		x	x	x	3	18 (53%)
	x	x	x		7	
	x	x		x	8	
4	x	x	x	x	4	4 (12%)
Total	27 (79%)	30 (88%)	18 (53%)	17 (50%)	34 (100%)	34 (100%)

However, since the road stretch was not long enough, a direct conclusion was hard to derive. A driving behavior survey might shed more light on this.

6 SURVEY

To enrich the database, as a complementary study, an on-line survey has been carried out. Since many drivers can be reached by an on-line survey, it is a fruitful tool to analyze the possible correlations between the driver characteristics and strategy-based lane change behavior. The survey setup is discussed first and then the outcome and findings of the survey follow.

6.1 Setup

The survey starts with a picture of an empty three-lane freeway. For this situation, it has been asked which lane the respondent will choose and what his speed will be in this situation. Based on the answers, the participants will get a personalized survey in which the speeds and lane are related to his own driving behavior.

The survey was set up to find out the driver's strategy from a series of questions, designed using the videos of the test-drives (see Figure 3a and Figure 3b for the screen shot of the original video and the modified version implemented in the on-line survey). The survey has been set-up in the survey tool called Typeform. As shown in Figure 3b, the modified version, includes a speed limit sign (adapted based on the driver's preference) and an artificial rear view mirror showing the synchronized video recording of the rear view. The participant was asked 14 questions in several categories. In all movies, a view of the traffic situation from the driver's perspective is given, and

TABLE 2 Survey setup

	Category	Description
	Strategy 1,2,3	Questions to determine if a respondent drives according to strategy 1,2 or 3.
	Strategy 4	Questions to determine if a respondent drives according to strategy 4.
	Keep right rule	Questions to determine if a respondent strictly obeys to the keep right rule.
	Overtaking via right	Questions to determine if a respondent would overtake another driver via its right side.
	Courtesy lane change	Questions to determine if a respondent would make a courtesy lane change to create space for a merging vehicle
Question	Theme	Scenario in the question
1	Right overtaking	Would the respondent overtake another vehicle via its right side, while there is the possibility to overtake via the left side?
2	Strategy 1,2,3	Would the respondent overtake a slower predecessor (person car), or adjust its speed and keep lane?
3	Strategy 1,2,3	If the respondent would overtake a slightly slower predecessor, would he do this according to strategy 1 or 2?
4	Strategy 1,2,3	Is a respondent during congestion trying to get in the fastest lane, or will he keep lane
5	Right overtaking	Would the respondent overtake another vehicle via its right side, when there is no possibility to overtake via the left side?
6	Strategy 1,2,3	If the respondent has to take the 2nd exit from where he entered the motorway (3000 metres), what strategy will he apply?
7	Keep right/Strategy 4	Does a respondent keep strictly right, or is this decision affected by the presence of other vehicles?
8	Keep right	Does a respondent keep strictly right, when there are not much other vehicles around?
9	Strategy 1,2,3	Would a respondent overtake a slower predecessor (truck), or adjust its speed and keep lane?
10	Keep right	How strict would a respondent obey to the keep right rule, when there are other vehicles around?
11	Strategy 4	Would a respondent increase its speed above its own desired speed and the speed limit when all other drivers do so?
12	Courtesy lane change	Would a respondent cooperate with a driver on the on-ramp that wants to merge?
13	Strategy 1,2,3	If the respondents have to take the exit 600 metres up ahead, would they overtake a truck just before the off-ramp?
14	Keep right	Would a respondent keep right when the peak hour lane is opened?

it was asked what the drivers would do if they were in that vehicle. On average, the survey took 17 minutes to complete.

The main research themes of the survey are listed in the upper half of Table 2. Based on these themes, questions were formulated and they are reported in the lower half of Table 2. Sometimes the questions are slightly different, so that the consistency of the respondents can be tested. Apart from the driving-strategy-related questions, also the basic characteristics of the respondents such as age, yearly mileage and the area where they normally drive, were asked.

The survey was distributed among the people who participated in the driving test, and the network of the involved researchers. Moreover, it has been distributed via communication of the Royal Dutch Touring Club (ANWB). Generally, the social media and e-mail newsletter of this organization are distributed to millions of Dutch motorists. To stimulate people to participate, a gift card of 50 euros was promised as a prize awarded to one randomly chosen participant. In total, 1,258 participants completed the survey. As demonstrated in Figure 1, the resulting group is not homogeneously distributed over ages. There is a peak for younger drivers (20-25 years old), possibly due to university involvement, and a peak for more senior drivers (over 60 years old).

The respondents who also took part in the test-drive, were asked to identify themselves. This allowed to check whether the survey responses show the same pattern as found in the test-drive. Moreover, for the individual questions in the survey, it was tried to compare the responses of the test-drive participant with his/her behavior observed (recorded) in the actual test-drive. In addition, the responses of the respondents which also took part in the driving test have been compared with the strategies shown in the test-drive. For several questions it has been analyzed whether the strategy in the survey matches the profile as found in the test-drive: the answers to 6 questions (i.e., questions 2, 3, 4, 6, 9 and 13) were analyzed, and checked whether the chosen strategies match the set of strategies found in the test drive.

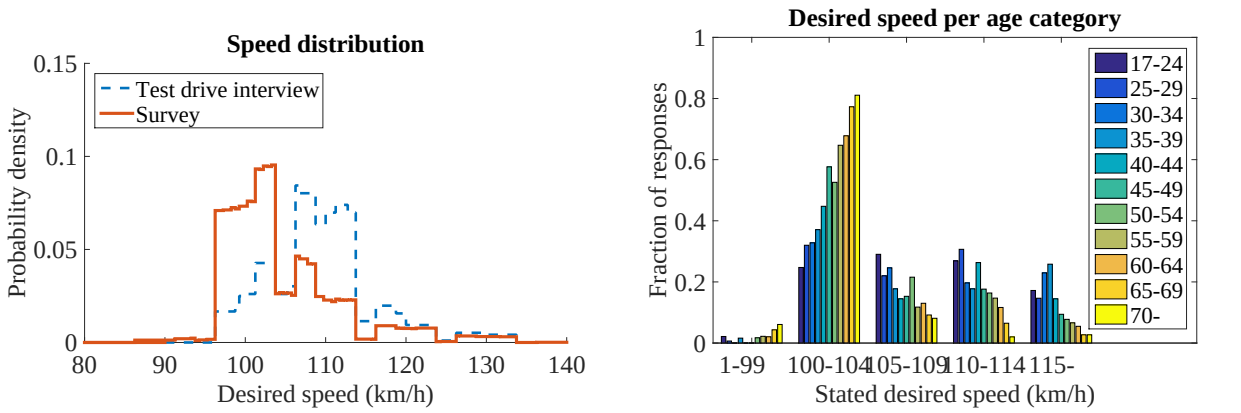
To obtain the results, not only an element-wise analysis of the different aspects was carried out, but also a cross-correlations analysis. In addition, where applicable, statistical testing has been applied. We will report on the size of the effect, as well as the significance of the effect. The first indicates how much one variable changes with a change in the other variable and the second shows whether this is likely to be a coincidence. The most important cross-correlations studies are between the age and the desired speed, and also between the age and the applied strategy.

6.2 Results

Firstly, a face validation is carried out, by comparing the responses from the respondents who also participated in the driving test. This can be done in two ways. The first is as follows. The questions in the survey come from the driving study. It can be compared whether the respondent in whose trip the movie was recorded answers the same in the survey as what he did in the test drive. A second way of face validation is testing whether the answers someone gives in the survey are in line with the strategies he showed in the test drive.

For the first way, 7 questions could be checked. In 4 out of the 7 cases, the stated preference (in the survey) was exactly the same as the behavior the participant showed in the test-drive. Given the number of options (approximately 5 per question), this is pretty consistent. However, since the drivers have shown to have multiple strategies while driving (see Table 1), other approaches of coping with a specific situation is not surprising.

For the second way, from the survey 25 respondents could be identified as the people who



(a) Speed distribution test-drive and survey

(b) Desired speed distribution survey per age category

FIGURE 4 Distribution of quoted desired speeds at a road of a 100 km/h speed limit

also participated in the test-drive, which each are requested to choose 6 times between strategy 1,2 and 3. Accounting for 7 missing or other answers, that gives 6*25-7=143 strategies. Moreover, 4 out of these 25 respondents answer to use strategy 4 in question 11. In total, we hence have 143+4=147 chosen strategies, which we can compare with the set of applied strategies found in the test-drive. For the majority of these chosen strategies (127 or 86%) the given response is in line with one of the strategies derived in the test-drive, and so the rest (20 or 14%) is not in line. One respondent indicated a different strategy in 4 questions, one respondent pointed out a different strategy in 3 questions, and two respondents indicated a different strategy in two questions; 9 respondents indicated a different strategy in 1 question and 12 respondents indicated all questions in line with the strategies from the test drive. Overall, we believe this shows that the survey is well in line with the results shown in the test drive, and can therefore be used as representative for the driving behavior.

The desired speeds are given in 4a. It shows that the desired speed of the respondents of the survey is lower than the speed of the participants of the test. This might be due to the age of the participants. Figure 4b shows how the desired speed depends on the age: a larger fraction of the younger drivers drives fast, whereas older drivers drive mostly at or just above the speed limit. This change is small, but statistically significant. Moreover, drivers which drive a high mileage show a statistically significant higher desired speed. This reveals the relationship between desired speed and driving frequency.

Table 3 shows how the responses of the survey lead to a distribution over strategies. Not all questions lead to the same distribution of respondents over the categories, which is in line with the effect seen in the test-drive. Nevertheless, we can derive a tendency: strategy 1 is chosen most often, then strategy 3, then strategy 2, then strategy 4. The lower part of table 3 shows that strategy 1 is used by almost every participant and also strategy 3 is used by 3/4 of the drivers. Strategy 2 is used by just over half of the drivers and strategy 4 is rarely used.

Table 4 shows to which extent respondents are keeping the right lane. A majority of roughly three quarters of the respondents would normally go back to the right lane if there is a possibility. Only for question 7, this fraction is lower. This is likely due to the fact that another vehicle is present in the center lane. Drivers do not prefer to switch lanes frequently. One participant commented: “If I have to change lanes again within 10 seconds, I will not go to the right. If I can

TABLE 3 Distribution of respondents over the lane change strategies

		Lane change strategy							Other answers
		1	2	3	4	1/2	3/4	3*	
		Responses per question							
Question	Theme								
2	Strategy 1,2,3	77%	10%	12%	1%	-	-	-	0%
3	Strategy 1,2,3	56%	43%	-	-	-	-	-	1%
4	Strategy 1,2,3	-	-	-	-	27%	73%	-	0%
6	Strategy 1,2,3	-	-	44%	-	28%	-	27%	1%
9	Strategy 1,2,3	85%	11%	3%	-	-	-	-	1%
11	Strategy 4	-	-	-	12%	87%	-	-	1%
13	Strategy 1,2,3	20%	19%	61%	-	-	-	-	1%
		Cumulative use of strategies							
Number of participants		1211	665	931	11	1220	336	341	
Percentage of participants		96%	53%	74%	1%	97%	27%	27	

TABLE 4 Distribution of respondents to behaviour characteristics

Question	Theme	Changing to rightmost lane?	
		Yes	No
7	Keep right/Strategy 4	57%	42%
8	Keep right	88%	12%
10	Keep right	76%	23%
14	Keep right	73%	25%
		Right overtaking?	
		Yes	No
1	Right overtaking	20%	80%
5	Right overtaking	16%	84%
		Cooperative behaviour?	
		Yes	No
		Lane change / Speed adjustment	
12	Courtesy lane change	72% / 11%	16%

stay for 10 or more seconds, I will".

The vast majority of the respondents indicated that they would not overtake at the right, see table 4. Table 4 also shows the cooperative behavior. If another driver indicates the desire to change lane (e.g. the on-ramp lane ends, blinker on), 83% of the drivers will facilitate this lane change. Most will do so by changing a lane towards the left. Others (11%) will reduce speed to allow the vehicle to merge in front.

A final analysis was done for the area in the Netherlands where people drive the most. It was checked if that aspect influenced the lane change strategy, but for this aspect no significant effects have been found.

7 DISCUSSION AND CONCLUSIONS

In this paper, people's driving strategies at the freeway have been studied. A total of 34 people took part in a test-drive in an instrumented vehicle, and were interviewed afterwards. The interviews gave an in-depth insight into the motivations of drivers for taking a specific action, but still they were limited in number. Better statistical analysis could be carried out based on a larger database, which was derived from an on-line survey. For this survey, an on-line survey has been designed utilizing the videos captured during the test-drive and a adequate number of 1258 people responded to the on-line survey.

The test-drive revealed that people have different strategies throughout their trip. Sometimes, they stick to a specific speed and adapt the lane accordingly, and sometimes they stick to a lane and adapt their speed. Hence, it would not be completely correct to model drivers as having one speed, and make the lane choice depending on the possibilities to maintain driving at that speed. However, in terms of frequency, people tend to have a speed leading strategy more often than a lane leading strategy.

These results were confirmed in the survey, where most people chose a speed first and adapt the lane based on it. Less often people would have a strategy with a desired speed, but change their desired speed during overtaking. Also the strategy to choose a lane and adapt the speed accordingly is chosen less often then the strategy with the fixed desired speed. Only a small fraction of the drivers would neither have a desired speed nor a desired lane. A large number (75-80%) of the respondents indicated that they would return to the right lane, and over 80% refrained from overtaking at the right. In conclusion, overall, around 75% can be described as having a specific speed in mind. The remaining 25% is behaving fundamentally different.

In over 80% of the cases, drivers were willing to adapt their speed or (more frequently) their lane to facilitate a mandatory lane change of another driver. This courtesy behavior should also definitely be incorporated into microscopic models.

In addition, the paper introduces a desired speed distribution of 100 km/h on the freeway. Note that this is indeed on average, slightly above the speed limit, and younger drivers had a significantly higher desired speed. Moreover, drivers who had higher mileage, had a higher desired speed than those who drive less; this effect is statistically significant, but very small in size.

The results presented here are valid for Dutch drivers. Consistent behavior has been found among the drivers in different areas in the Netherlands. However, results are expected to differ for other countries. This paper presents a setup which can be used for other countries as well. Future research includes performing this study for an international group of participants and comparing driving strategies of drivers from various countries.

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