17. A STUDY OF THE BEHAVIOUR OF DRIVERS OF ELECTRIC MINICARS

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17.1 INTRODUCTION

In Switzerland there exist many regions where the use of conventional cars is restricted. More restrictions are being discussed. The alpine regions with their natural beauty obviously constantly remind both decision makers and citizens that nature is something that has to be protected. In Switzerland it is maybe more obvious that nature is not something that exists independently of people and their everyday life; we are part of nature, even if we often do not act in agreement with this fact.

Thus, it seems to be the wish to protect nature - nature where people live, come to have holidays, raise their cattle, etc. - rather than a traffic-safety perspective that lead to astonishingly concentrated efforts to promote electric minicars in Switzerland. These vehicles are supposed to be less space-consuming, to cause less noise, and to cause less air pollution than ordinary cars. (Everybody can see that these three aspects are really of vital interest when he/she travels to Austrian alpine valleys: Car traffic has so far not been restricted very much, there, and the results are quite depressing, both from an aesthetical and from a life quality point of view that maybe both aspects are part of the same dimension.)

In 1991 the Institute of Forensic Medicine in Zuerich was asked by the Swiss Government to carry out a series of research projects in order to check feasibility aspects connected to the promotion of electric minicars in today's traffic. One important and heaviliy dicussed question was if electric minicars were "safe" at all - "safe" in the sense of the driver being sufficiently protected in case of an accident. The crash-tests performed in order to answer this question showed that there was no reason to be too pessimistic, as far as the driver's safety was concerned. Additionally, from behaviour adaptation theory the argument was derived that with some probability electric minicars would be driven in a more cautious way. Drivers who do not feel a hundred percent safe would take fewer risks. This would add to the protection of the environment in a broader sense, which could result in advantages for other road users, mainly the vulnerable ones. The Viennese Institute FACTUM was asked by Felix WALZ, the representant of the Institute of Forensic Medicine, to analyse if electric minicars really have the potential of being an even socially well sustainable alternative to the conventional car.
The results of this study that was financed by the **"Schweizerischer Fonds für Verkehrssicherheit"** and the **"Bundesamt für Energiewirtschaft Bern"** will be discussed in the following chapters.

17.2 ROAD TRAFFIC AS A SYSTEM

Traffic safety research has - from a psychological perspective - been practised internationally since many decades. The reduction of accident numbers can be seen as the priority task from the beginning. In a survey about the historical development of traffic psychology, KLEBELSBERG (1988) points out that in the last time the development has slowly "shifted from safety evaluation to system evaluation":

When evaluating safety measures, it is not enough to rely on accident numbers as the only safety criteria. Economy, mobility, comfort, and other aspects have to be considered as well. Safety in traffic is not only relevant for society because of it's implications for physical integrity of people, and because of its potential to reduce societal costs caused by accidents. Subjective safety - i.e., the feeling of being safe or not - is intimately connected to human life quality. Not least, the fear to get involved in a traffic accident could disturb mobility of certain types of road users. Many studies have shown that especially subjects who do not have the possibility to use a car experience fear in traffic, whereas people who frequently drive a car do not report about any felt lack of safety when travelling in their car. It has to be realized that analysis and measures in road traffic must always take place regarding the whole system, and that this system we are talking about is a **social system**.

Recent traffic research quite frequently reflects the fact that studies about the nature of safety can only be really successful and efficient if traffic behaviour is seen in a social context and if the individual person is seen as a homo socialis. Research we did in Austria (CHALOUPKA et al. 1991) led us more and more away from looking at the driver as **one isolated individual under a kind of laboratory conditions**. The description of driver behaviour without considering social-psychological stimuli (i.e., all kind of stimuli that have to do with the overt or mental presence of other road users) is - maybe - fundamental, but it does not reflect traffic reality: The individual car driver does not fulfil tasks similar to solving mathematical equations at his desk, or digesting some food or medicin, or repairing a bycicle (the mere handling of a car is probably much easier than repairing a bycicle): Most of the time, the driver interacts in some way with other road users/with other people.

17.3 WHAT IS A SAFE CAR?

We should bear the arguments above in mind when we aks this question. Problems with traffic in densely inhabited areas are to a high degree related to car traffic: Noise, air pollution, space consumption. In many larger European cities authorities have already started to try to both incite people to use other traffic modes than the private car, and to use the private car in another way than today (less often, less risky, more slowly; see MONHEIM & MONHEIM-DARNDORFER 1991, SACHS 1985, a.o.).

Another option is to change some characteristics of the private cars. In Sweden, experiments are going on in order to test behaviour of drivers of speed limited cars: Speed in inhabited areas is automatically limited to the existing speed limit (PERSSON et al. 1993; ALMQUIST et al. 1991). Also at the University of Lund a scheme was developed for how to analyse the behaviour of drivers of electric minicars (that was preceded by an acceptance study: SCHROEDER 1990). The central hypotheses in both cases: Behaviour of drivers both in speed-limited conventional cars and in electric minicars will be comparably safe.

And in both cases the definition of driving a car safely was related to aspects of the social framework in traffic: The degree of safety is defined by the degree to which car drivers adapt their behaviour to existence and behaviour of other road users, especially as far as unprotected road users are concerned. From this perspective, we expected that electric minicars are **safer than conventional cars**.

When people say that electric minicars are unsafe, they ususally refer to crash-tests, as was already said above: Earlier tests have shown, that in case of accidents drivers are not very safe in minicars. This maybe true, even if this kind of passive safety has improved considerably during the last year (see STRAUSS 1992). What is interesting, however, is that, according to the state of the art **large, strong, and well equipped cars get involved into accidents relatively more often than smaller ones** (PFAFFEROTT 1992). This would allow the hypothesis that drivers behave more cautiously if they do not feel a hundred percent safe in their car, which can obviously be interpreted as some kind of behaviour adaptation (OECD 1990; RISSER R. & CHALOUPKA CH. 1993).

It seems reasonable to analyse the behaviour of drivers, and how they interact with other road users, in order to find out, how different degrees of involvement in accidents can be explained. The central role of interaction in road traffic is underlined by the fact, that around 75% of the accidents in the industrialised countries are accidents between two or more road users.

And as far as interaction with VRUs is concerned, another interesting figure from accident statistics can be presented: **During the last years 25% of all road users killed in Austria per year were pedestrians, in Vienna this percentage was around 60%!** Does this mean that shoes are very unsafe vehicles? Or do pedestrians and cyclists kill themselves by throwing themselves under cars?

17.4 PROS AND CONS CONNECTED TO ELECTRIC MINICARS

If the hypothesis that electric minicars are driven in a more cautious way than conventional cars is right, this is certainly in advantage of the electric minicar, apart from other advantages like being less space-consuming, less noisy, and at first sight, even less air-polluting. However there certainly are some arguments to the disadvantage of electric minicars, as well:

* If cars are developed that are better compatible with the situation in densely inhabited are this might lead to a strong increase of vehicles in such areas, the electric minicar then maybe being the second or third car in the family that is mainly used in the city.

* Energy has to be taken from somewhere. Is it certain that electricity comes from sources that do not cause any environmental problems?

* As the time span of transition from today's traffic to a traffic with a high percentage of electric minicars will certainly be quite long, there is some probability that drivers of minicars will develop some strategies for "survival" that in the long run lead to negative impacts on the traffic climate (e.g., to demonstrate that one is not so weak as it looks) - a little bit like cyclists in cities where cycling is a "new" way of transportation.

The last con just named was central to the study that will be described here. When the Institute of Forensic Medicine at the University of Zurich, till then mainly dealing with the consequences of crashes electric minicars might get involved in, became interested in **active-safety questions** as well, they heard that FACTUM in Vienna had some know-how on how to deal with such questions. It was decided that we should do behaviour observation studies to analyse the traffic-safety aspects connected to the electric minicar.

17.5 A STUDY IN VIENNA AND ZURICH

Work was started with the development of the following **hypotheses about the consequences of the introduction of electric minicars in to-day's traffic**:

a Of obvious reasons speeding will decrease, average speeds when driving electric minicars will be lower
b Phenomena very much connected to higher speeds that reflect impatience and lack of preparedness to cooperate - e.g., pressing by keeping very short distance to the preceeding car - will not occur so often in connection with electric minicars
c Interaction with vulnerable road users (VRUs), e.g., when turning left or right and having to cross the way of VRUs walking/riding straight on, will improve in quality, as the difference in power and size is not so great
d Behaviour at cross roads when not having the right of way will become more cautious, accepted gaps will become longer, as one is more vulnerable
e Insisting on one's right of way will happen more cautiously, as well, of the same reason

However, some **negative behavioural consequences** can be expected, as well: One "is smaller and weaker" and one might be led to"fight back" in case feelings of "not being respected", etc., arise. Moreover, being surrounded by fast vehicles, the tendency to compete could still be kept alive and maybe even grow, possibly leading to negative consequences:

f One of them could be inadequate speed in situations when one actually should drive very slowly (narrow inhabited streets, etc.)
g Overtaking cyclists and moped riders where there is only little space, and similar types of behaviour could become more frequent
h It is also possible that one "forwards" bad treatment one gets from drivers of conventional cars to pedestrians and cyclists
i driving against red and yellow light could become more frequent

17.6 A METHOD FOR EVALUATION

As an evaluation method we used the "Wiener Fahrprobe" (Vienna Driving Test; RISSER 1985; revised version CHALOUPKA et al. 1991, GSTALTER 1990, FASTENMEIER 1990), which was modified considerably, however: The reason is that a SOLEC-Riva car was used (see photo on the next page), where there is only space for the driver and one observer. Behaviour variables the "remaining" observer should register were the following:

- **speeding**
- **short headways**
- **lateral distances** (to pavements, parked cars, cyclists, mopeds)
- behaviour at **pedestrian crossings** (correct, frienldly, dominant)
- **turning left or right** (interaction with oncoming traffic and with VRUs walking/riding straight on
- behaviour in cases where **other road users have the right of way** (correct, submissive, dominant)
- insisting on **one's own right of way**
- character of **lane changes**

These variables are registered on a standardised form that has to be filled in per section.

The Electric Minicar

Other types of behaviour that cannot be specified well in advance are registered freely, i.e., they are described in words. These variables consist mainly of three types:

- **erroneous behaviour** (illegal, dangerous, or both; unclear behaviour that might be misunderstood, or that reflects misunderstanding of others' intentions)
- **communication processes** of all types (independent of their character, and independently of the fact if erroneous or not)
- **traffic conflicts** reflecting imminent danger

17.7 PROCEDURE

The question we wanted to answer as a result of our study was: **Is behaviour when driving electric minicars to be judged as positive or negative compared to driving conventional cars?** In order to answer this question we had 50 persons in Vienna and 10 persons in Zuerich drive on standardised routes in both cities twice: Once with their own car and once with the electric minicar. Half of the test persons drove with the minicar first and vice versa.

In the year 1992 (in June, July and September) 50 persons were observed twice on a standardised route in Vienna, once when driving their own car and once when driving the electric minicar. In October of the same year 10 persons, also once driving with their own car and once with an electric minicar, were observed on a standardised route in Zuerich.

All observations were done by one observer, in eight cases a second observer (a partner in the project) did observations together with the main observer in the subjects' own cars, in order to check inter-rater correlation.

17.8 RESULTS

The results can be divided into two parts: 1) Impressions of the observer and summary of the subjects' comments and 2) Quantified behaviour registrations with the help of the Wiener Fahrprobe.

17.8.1. Impressions and comments

Generally, the observer sustains that driving an electric minicar influences behaviour positively. With the minicar, subjects roll towards crossroads, zebra crossings, and obstacles, rather than driving towards them more quickly and then braking, as is the usual behaviour. Interaction rather changes towards more cooperation and seems to be less dominant with respect to VRUs.

* The first impression is that there are **no striking differences between driving a conventional car and an electric minicar**. Drivers maintained their driving-style, it seemed. When people started driving the minicar they were usually a little bit hesitant and there were some handling problems, to start with, but after 10 to 15 minutes such problems usually vanished, not unexpectedly (see STEINBRECHER 1991; quite usually people commented that "now I got a little bit used to the test car"). The more time went, the more subjects expressed their surprise about the fact that they could follow the traffic so well without being an obstacle.

* Five persons expressed some concern about the fact that they were **pressed by the other car drivers**: This led to the feeling that they had to drive as far to the right of the road as possible, or not to stop at a pedestrian crossing because they were afraid that other cars would hit them from behind. Even on uphill sections of the route the tendency to drive as far to the right as possible was observable.

* In the present study **communication with other car drivers** was a very artificial variable, as communication was obviously enhanced by the fact that the electric minicar raised a lot of interest. One moped-rider started quarrelling because he got surprised by the electric car that had approached him from behind so silently. However, reactions from other road users were very positive generally speaking: Firstly, the minicar is something new and unusual, and secondly the minicar seems to cause a kind of "baby-effect" - everybody is friendly and nice as long as there are not too many of these disturbing creatures around.

* Several subjects said that they **would like to buy such an electric minicar right away**. However, as prices are still very high, this attitude changed quite quickly when the price was named.

17.8.2 Some behaviour changes

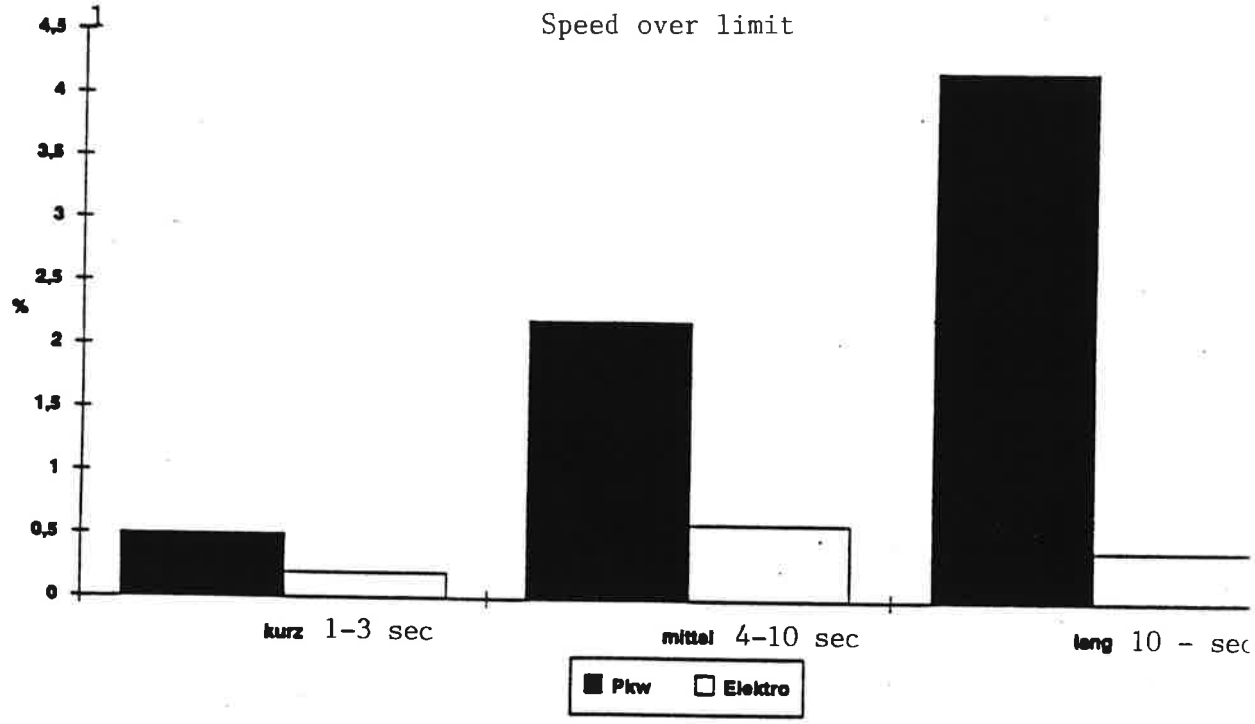
The results of the behaviour observations as related to the hypotheses in chapter 5 were the following:

Hypothesis a: Speeding, especially speeding over a longer time period, was less frequent in the electric minicar (fig 1)

Hypothesis b: This hypothesis is based on the assumption that impatience is reflected by short headways, by driving against red, and similar phenomenons. The behaviour observation showed that short headways became less frequent when driving electric minicars. But at traffic lights subjects driving conventional cars did not behave differently from when driving an electric minicar. It is not quite clear if behaviour of people driving electric minicars reflects less impatience.

Hypothesis c: Interaction and communication with VRUs is better when drivers are driving electric minicars than when they drive their own car. Especially when turning left or right and thereby crossing the way of VRUs walking/ travelling straight on drivers in minicars do not disturb VRUs as often as do drivers in conventional cars (fig 2). In the minicars there is also more preparedness to decelerate and to approach VRUs at a lower speed.

Figure 1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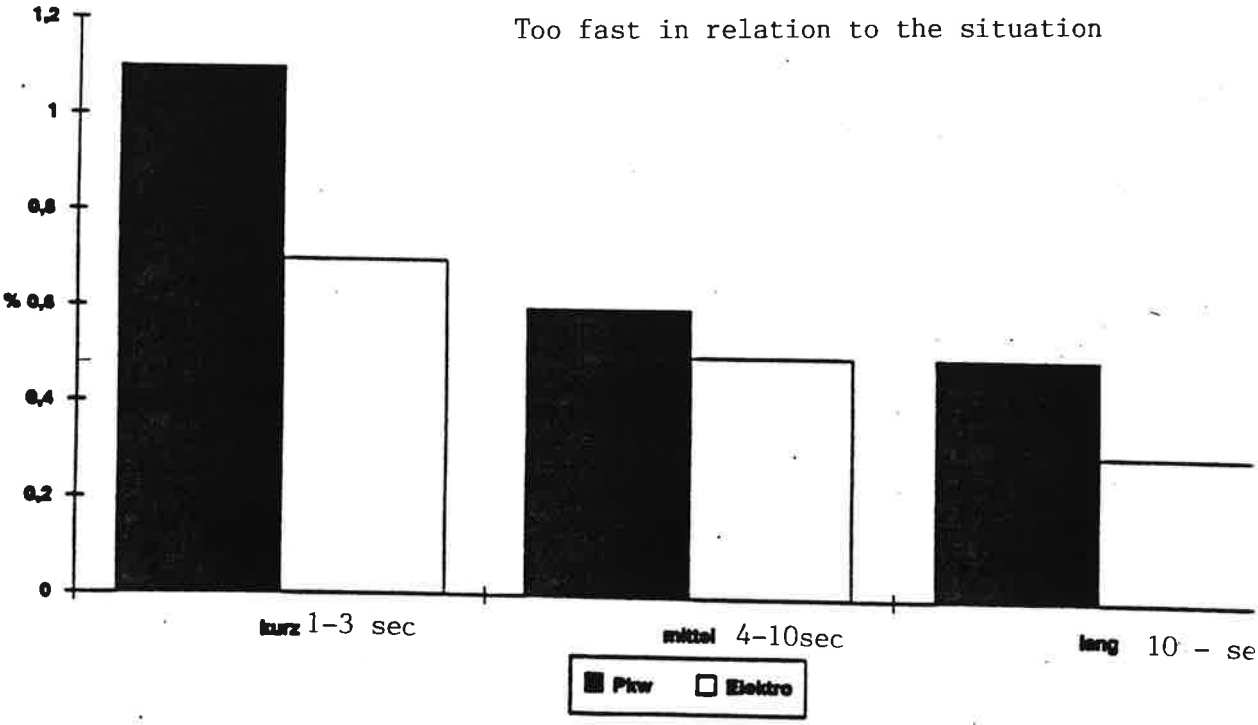
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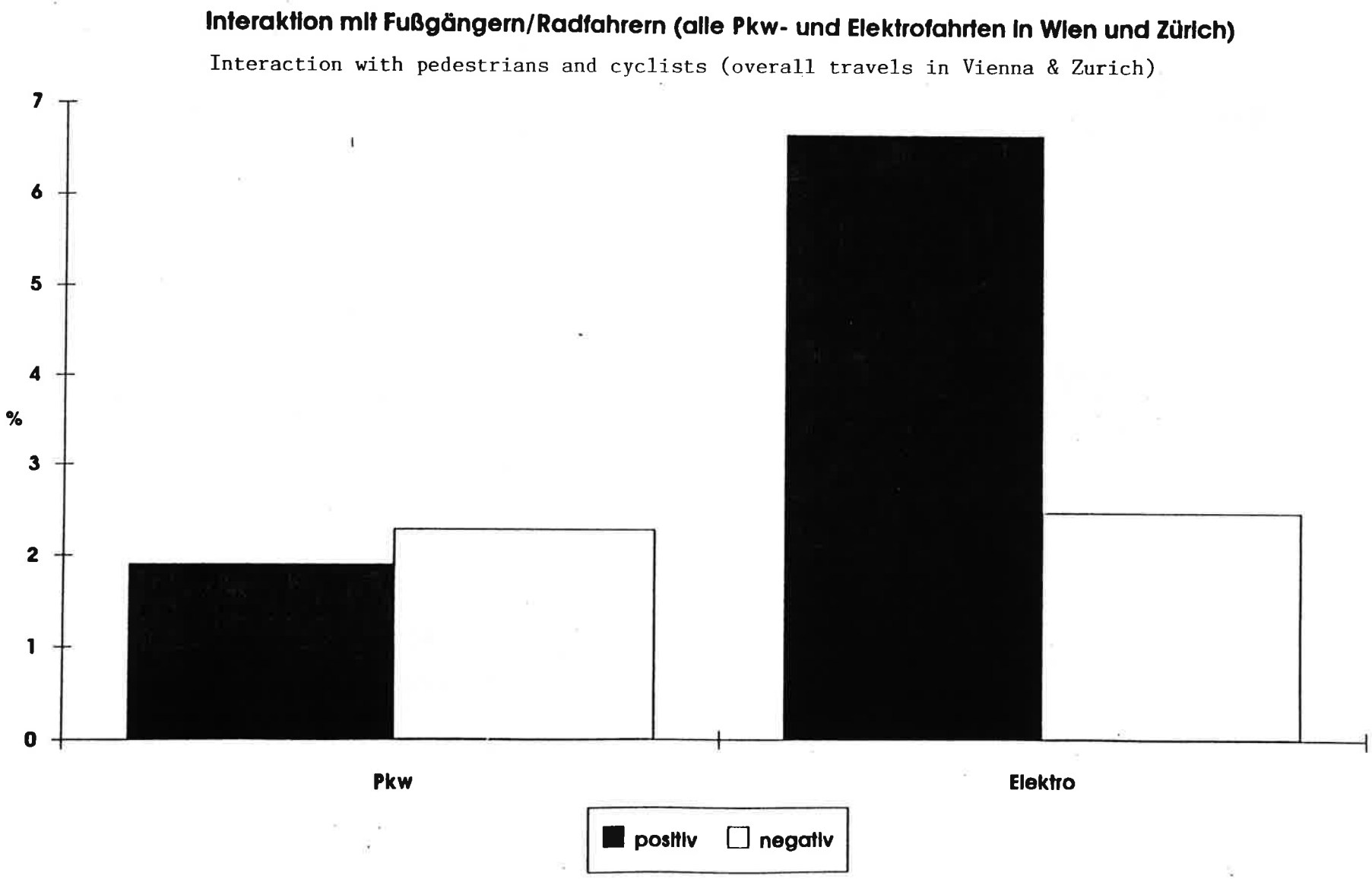
Interaktion mit Fußgängern/Radfahrern (alle Pkw- und Elektrofahrten in Wien und Zürich)
Interaction with pedestrians and cyclists (overall travels in Vienna & Zurich)
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5
4
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3
2
1
0
Pkw
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positiv
negativ

Figure 2

Hypothesis d: There is no difference between people driving minicars or conventional cars with respect to behaviour in those cases when other car-drivers have the right of way. Infringements and errors happen with the same frequency in both cases.

Hypothesis e: Inadequately insisting on one's own right of way happens as often when driving an electric car as when driving a conventional car.

Hypothesis f: Inferiority feelings supposedly connected to driving of a minicar (smaller size, less power, etc.) according to our expectations could leed to compensatory behaviour. E.g., one could expect non-sufficient speed adaptation in such situations where an adaptation under the speed limit is necessary. However, in this respect there was no difference between subjects driving a conventional car and driving an electric minicar.

Hypotheses g: Another possibility for drivers of electric minicars to compensate is to overtake bycicles and mopeds in situations where there would not be enough space for drivers of conventional cars. We could however not find any differences between minicars and conventional cars.

Hypothesis h: We could not detect any behaviour reflecting the main statement of this hypothesis, that VRUs will "have to pay for the disadvantages drivers of minicars experience" in today's traffic (see hypothesis c).

Hypothesis i: Driving against amber and red happens with the same frequency in the conventional-car mode and in the electric-minicar mode.

To finish with, I want to present a table that to a certain degree reflects subjective safety during the test ride (table 1):

Table 1: Did you feel safe during the test ride?

Feeling of safety	cc Vienna	elm Vienna	cc Zuerich	elm Zuerich
very safe	72%	52%	70%	20%
safe	25%	41%	30%	70%
partly unsafe	0%	7%	0%	10%
unsafe	3%	0%	0%	0%
very unsafe	0%	0%	0%	0% .
	100	100	100	100

cc = conventional car
elm = electric minicar

This table showes that there is good reason to assume that drivers do not feel as safe in electric minicars as they do in their own conventional cars. Of course, it would be interesting to interview some people who have been driving electric minicars for a longer time and who have become used to that, with respect to this question. But this will be part of further projects.

17.9 CONCLUSION

Summing up one can say that drivers behave slightly more safely and socially acceptable (fig 2) in electric minicars than when driving their own conventional car. However, if anybody had expected a more "humble" behaviour in electric minicars, because of the inferiority with respect to power and speed - where "humble" is something positive and means cooperative, patient, etc. - he/she would be disappointed with the results presented here. Driving a car is an activity intimately related to a social field. One feels the impatience of others, is pressed by others, is overtaken by others, experiences advantages of others who drive past fast, and so on. The social environment does not provide for much reinforcement for those who drive slowly, renounce in their right of way, consider other road users' needs, etc. This means that we should not be surprised by the fact that car drivers try to behave like "ordinary" car drivers even when they are sitting in an electric minicar.

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