7. THE SPEED LIMITER IN THE CAR FOR SAFER TRAFFIC AND BETTER SOCIAL CLIMATE IN THE CITIES

Christer HYDÉN

Lund Institute of Technology
Lund Sweden

7.1. INTRODUCTION

In all the countries of the western part of Europe one big traffic-safety problem is created by the fact that car drivers do not comply to the speed limits set by the authorities. This problem seems to be fairly independent of the type of limit itself, and it has to be seen independently from the theoretical discussion about which speed limits are adequate for different circumstances from a traffic safety perspective.

The importance of speed from a safety point of view is accepted by a large part of the researchers in the field. Empirical evidence is showing very clearly that a reduction of speeds (e.g. by a reduction of the speed limit) does produce a very significant drop of accidents, the more severe types the greater is the reduction. There is, however, also indications that a reduction of speeds create a better social climate in general. A study on the effect of car drivers' behaviour versus pedestrians - when speeds were forced down by mini-round abouts at major intersections - showed that there was a significant increase of car drivers that stopped and let pedestrians pass at zebra crossings. Interviews with users also indicated that the 'climate' had been improved (HYDÉN, ODELID & VARHELYI, 1992).

Thus, there seems to be a big consensus regarding the need for countermeasures that can deal with the speed problem in an efficient way. Of course the main target should be speed adaptation, i.e. most important would be to see to it that car drivers actually adapted their speed to the prevailing conditions at every moment. An important first step, however, is to establish an understanding and compliance with the present speed limits. Even though rigid, they still represent societal demands regarding proper speeds in different environments.

Efforts to achieve better compliance with speed limits have so far not been very successful. A lot of methods have been tried: new types of road design, humps and other types of hindrances plus law enforcement were and still are the ones most often used, as well as arguments for better compliance to speed regulations in the frame of traffic safety campaigns. Some of these methods are partly very efficient - e.g. speed humps - but they are only locally efficient, at the same time as they are attributed as being much too expensive to install in all places where they theoretically are needed. Some others of these methods are inefficient, or their efficiency is very difficult to be proved in a short term - e.g. safety campaigns.

At our Department we have tried to look at the problem from another angle: So far, very little has been done regarding "the most natural" thing to do, namely "to control the process" directly at the source, i.e. in the vehicle. We have, therefore, initiated a project about a **speed limiter - SL**. Theoretically, the concept is that every change of existing speed limit is represented by a sender emitting impulses, and each vehicle is equipped with a receiver able to understand these impulses and automatically limiting the vehicle's maximum speed to the speed limit in question

- we call this system for automatic and obligatory, i.e. the system is not possible to manipulate and works all the time.

It must be stressed from the beginning that we, at this stage, are focussing on built-up areas primarily, with speed limits from 30 km/h up to 70 km/h. It is also important at this stage to stress our opinion that the system has to be mandatory, i.e. that eventually it has to be in operation all the time and for everybody: Only a guarantee that a significant majority of car drivers will be complying with speed rules will provide for attitudes towards such a speed reducing measure like the SL that allow a smooth introduction and provide for a real improvement just because of that. Voluntary use would - according to our opinion - not change speed behaviour significantly. Why should it?

7.2 DEMAND FOR EVALUATION OF EFFECTS - GENERAL

The main problem for testing such an automatic and obligatory system can be identified by now already: Such a system does not exist and it will be very difficult - and take some time - to provide for conditions simulating an automatic and obligatory speed limiting system even only in limited areas. Thus, our evaluation task has had to be limited in scope. This does not mean, however, that the task is 'unnecessary' or less important. On the contrary, the less we know about a concept the more important it is to start an evaluation process as early as possible. Evaluation of traffic engineering measures has to a very high extent been lacking in this long-term, 'slow-moving' process of evaluation. It seems as if the more drastic and comprehensive a measure is the less has been done to start a comprehensive evaluation process at an early stage. The introduction of seat-belts in cars is a good example. The only type of evaluation that started at an early stage was crash-tests and biomechanical modelling, etc, in order to find out the reduction of severity of casualties once in a crash. Pre-crash evaluation was not done at an early stage, thus creating a lot of hypothetical discussions at later stages about possible behavioural adaptation processes and similar problems that may reduce the effect of the measure.

Of course the task, even regarding evaluation of seat-belts, is not an easy one. But still, a theoretical preparation, linked with 'as intelligent' empirical studies as possible, had put both researchers and decision makers in a much more attractive position.

There is of course a great safety potential in a concept like the SL. Therefore it is of greatest importance to start an evaluation process as early as ever possible. Decision makers need a sophisticated base for their decisions. Demands to introduce an SL into road traffic will be put into effect only if it is absolutely certain that the advantages, from a safety and environmental viewpoint, will outweigh the disadvantages. So it is important to make an overall appraisal of the extent to which the SL can influence the traffic system, both positively and negatively.

7.3 INITIAL WORK

The Department started a project about an SL in 1986. In phase 1 of the project we carried out a literature study where the basic hypotheses about SL's possible impact on car driver behaviour have been guided by experts' interpretations of existing knowledge regarding car drivers' motives and actions (HYDÉN & ALMQVIST, 1987). More detailed formulations of

hypotheses were to be decided on in the following phases of the project. The next phase was formed around Round Table Discussions (RTD), an open form of discussion that can be used to broaden knowledge of a subject not yet discussed widely.

Concerning psychological aspects, the RTDs made clear that the question of acceptance, not explicitly included in the hypotheses named earlier, has to be given priority (see ALMQVIST, HYDÉN & RISSER, 1990). Moreover, it became more and more obvious to us which aspects of technical reliability and functioning smoothness that should be considered thoroughfully: Precision, manoeuvrability, adjustability, comfort, and hamper resistance.

In phase 3 - Self-observation studies - one car was equipped with an SL bought from Germany which met our specifications on technical reliability and functioning smoothness. Of course, it has to be manually turned on, for the time being. Personnel employed at our Department in Lund drove this car. By performing these studies the total list of hypotheses resulting from project phases 1 and 2 were to undergo a first testing, in order to be more well defined, completed, and operationalized.

These initial hypotheses are both concerned with the individual drivers' acceptance of the SL, respectively their reactions to it, and with the effects on an aggregated level (safety, noise, air-pollution). As a main result of phases 1-3 of our research work those hypotheses were verbalized and operationalized more in detail that deal with a situation where only few cars are equipped

7.4 FIELD TEST

7.4.1 Layout

In phase 4, 75 test drivers have been recruited. They have been driving the equipped car, with and without the SL activated, while their behaviour has been recorded simultaneously. The driving period was preceded by interviews to characterize attitudes regarding driving, traffic safety, traffic safety measures, etcetera. The idea was to choose drivers with different attitudes towards traffic safety issues, especially towards the importance of speeds, and measures to reduce speeds. After the test driving new interviews were conducted, focusing on reactions to the SL and changes in driver attitudes.

The observations were carried out by two observers in the vehicle. They used a modified version of the "Wiener Fahrprobe" with one "free observer" sitting on the passenger side in front and one observer sitting in the rear doing systematic observations of behaviour on each part of the test route (RISSER 1985). The "free observer" gave a general characteristic of the driver's driving style. In addition he recorded serious conflicts based on the Swedish conflict technique (HYDÉN 1987).

Additionally, time consumption, speeds, accelerations, and decelerations were recorded automatically with help of a datalog.

7.4.2 Restrictions

Being able to carry out 'real field tests' with 'real drivers' of course increases the possibilities to draw reliable conclusions regarding how an SL-system would work in real life. Still there is a long way to go before the field tests are representative of a situation with an automatic and obligatory SL-system:

* there is only our car equipped to-day, thus the test drivers will meet no other driver that is equipped.

* the test drivers do only have a limited experience with the SL. (They tested the system for 15 minutes before the test started).

* the test rides could not include 'normal' restrictions such as "being in a hurry", "becoming upset because of another driver's behaviour" (two observers were going together with the driver in the car), etc.

In spite of these restrictions a comprehensive evaluation is of course still "worthwhile". The point is that the aims of the study have to be limited. No definite answers on how people will react and behave in a "SL-system" (where every car is equipped and it works automatic and obligatory) can be expected at this stage. But answers to the question "is there a potential that is big enough to motivate further testing in a larger scale?" must be possible to achieve. This limited aim is credible enough and is just an adaptation to the limited possibilities that exist at his stage. But - as said before - this is what should be the normal procedure when developing new systems for safer traffic. Without this stepwise procedure the development has gone too far before any relevant feed-back is given in the developmental process.

7.5 RESULTS - EXAMPLES

7.5.1 Behavioural studies

Below one example from the continuous speed measuring is showed (Figure 1).

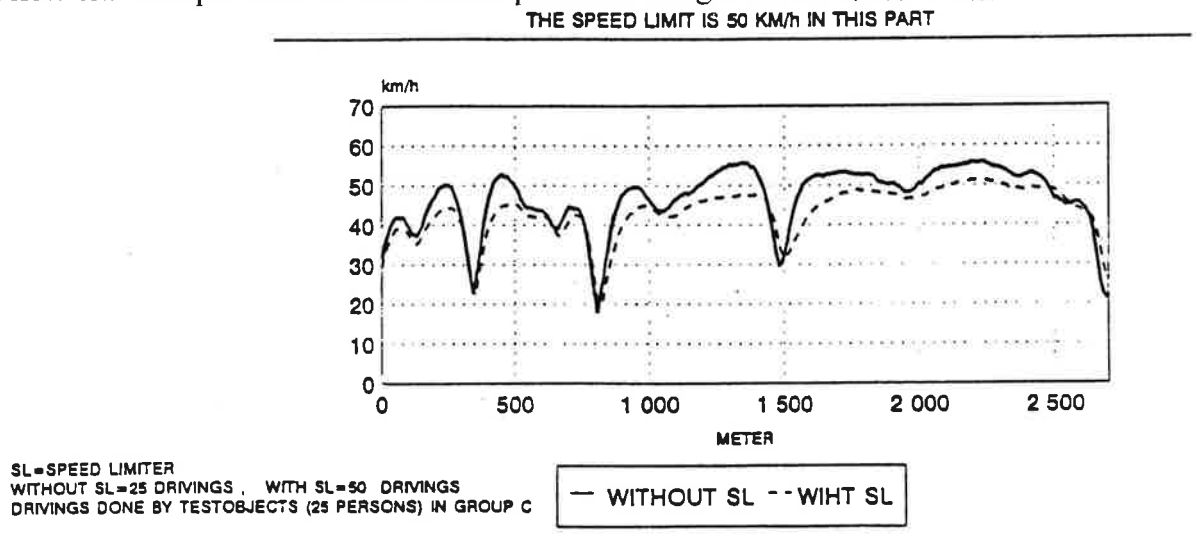

Figure 1: *Average speeds on section 1-2*

In figure 2 the portion of "improper behaviour" (i.e. driving against green-yellow or red) at traffic signals is shown, as one example from the behavioural studies.

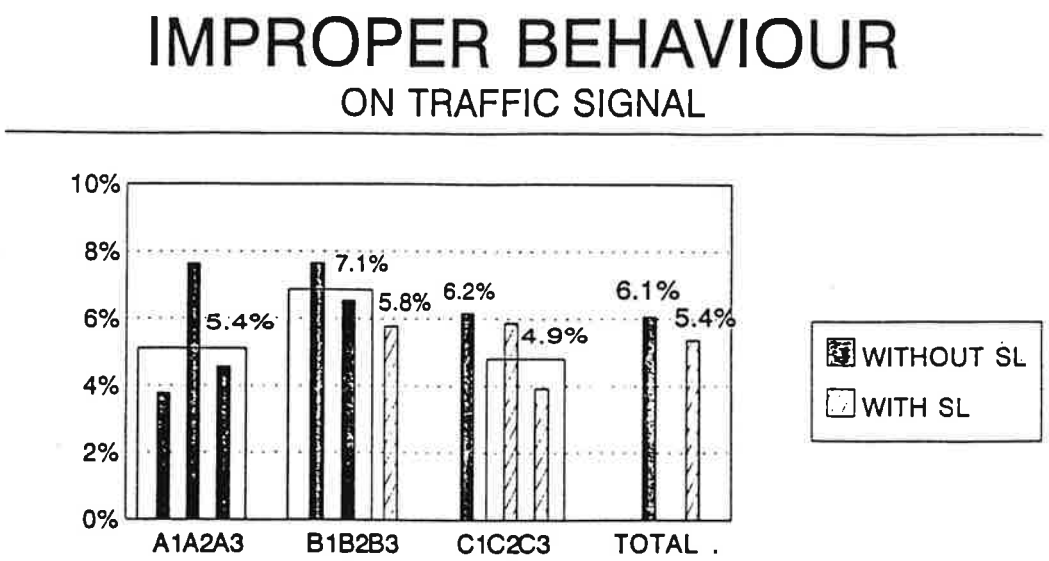

Figure 2: Portion of incorrect behaviours at traffic signals

Figure 3 shows the Portion of incorrect behaviours when the drivers were interacting with other drivers (i.e., when drivers were not slowing down or stopping when perceived by the observer as necessary, or the driver does not show his intentions for the other driver in a proper way).

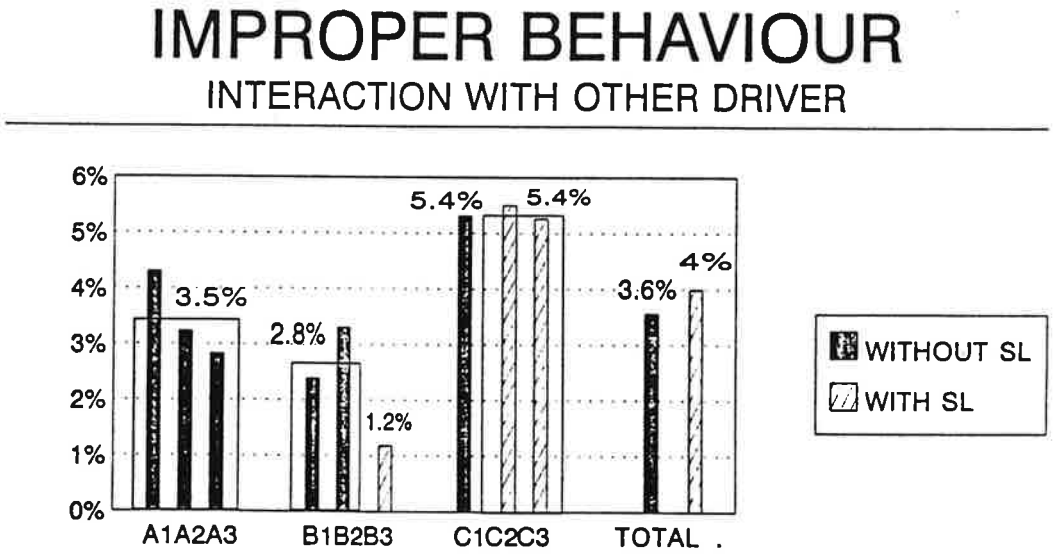

Figure 3: Portion of incorrect interacting behaviour of car drivers versus other drivers

7.5.2 Interviews

Results are presented both in general terms and specifically focused on testing the various hypotheses that are formulated. Below some examples only of the various types of results will be presented, while in the next section the main conclusions from the study will be presented.

Question: How did you like the SL-function?

Value content	Proportion of all answers (%)
Positive/neutral	68
Negative	23
Both positive an negative	9
Total	100

The positive/neutral answers were most often short and general:

- It works well
- It is ok with an SL
- Ok, nothing strange

A fairly common comment was that you got used to it after a while. The negative answers were dealing with unpleasant feelings, hinder, "staggered" driving and a "strange" feeling e.g. when one wanted to accelerate.

Question: How did you appreciate driving with an SL - was it stressing or was it rather relaxing?

Value content	Proportion of all answers (%)
Positive	38
Negative	22
Both positive and negative	21
Neither positive nor negative	19
Total	100

The positive answers were interpreted as expressions of changes when the SL was tested:

- More relaxing
- Relaxing. Not necessary to look at the speedometer.
- Relaxing. Definitely positive.

Negative answers were interpreted as negative changes, most often without explanations:

- Stressing
- Annoying
- Stressing when you cannot influence your speed.

Question: Imagine that all cars were equipped with an SL - and it worked obligatory; how would traffic work regarding car drivers?

Value content	Prop. of all answers (%)	
	Without SL	With SL
Only positive	30	56
Only negative	37	22
Both positive and negative	33	22
Total	100	100

After a test ride with the SL almost twice as many were only positive!

Most of the answers were fairly general, e.g.:
- Very good
- Would be good, increased safety
- Will be negative, degenerating

7.6 SUMMARY OF RESULTS AND CONCLUSIONS

The speed measurements showed expected changes of speeds between intersections, e.g. that speeds were reduced most on roads with the highest before-speeds. Average speeds decreased on average by 4.5 %. Regarding micro behaviour it was found that from a distance of 20 to 50 meters in advance of intersections until entering the intersections, the speeds of vehicles that were turning at the intersections were 1.6 km/h to 3.7 km/h higher of drivers with SL than drivers without. When leaving intersections the acceleration was lower with SL.

Time consumption increased on average by 33 seconds on the whole route (18 km), corresponding to a 2% increase. The emission of NO_x decreased by 5% and CO decreased by 1.4%, while fuel consumption was unchanged.

The in-car observations showed a decrease of the number of incorrect behaviours at traffic signals when driving with the SL and also a decrease of the number of incorrect behaviours regarding distance to vehicles in front.

Incorrect behaviour when interacting with other road users, however, did increase slightly when driving with SL, not statistically significant though. At the same time the number of serious conflicts was significantly lower when driving with SL, 17 without SL and 0 with. The reason for what initially could be seen as a discrepancy between the results of the interactions and the serious conflicts is fitting with our hypotheses about driving in mixed traffic with the SL: Incorrect interaction may occur when the lower speed of the vehicle gives, e.g., a pedestrian the idea that he may start crossing because the driver will let him pass. His own speed may, however, not (initially at least) change the driver's willingness to let the pedestrian pass. At the same time, the lower speed may increase his preparedness, and potential, of avoiding serious conflicts.

The interview results showed that most drivers seemed to adapt very quickly. In more than half of the answers there were no indication of limitations caused by the SL while in 40% of the answers there were remarks about the SL being a 'disturbance'.

Regarding the drivers view on expected effects in an 'SL-system' (where all cars were equipped and the SL worked automatically and obligatory) about one third of the respondents were positive, while the rest were either negative or 'neutral' (giving both positive and negative indications). Interesting, however, was that the share of positive answers were almost twice as high when drivers had tried the SL.

Regarding the hypotheses that were formulated in the earlier phases of the project one can conclude that hypotheses about a future 'SL-system' could only partly be commented based on the results from this study. Some major comments:

* One hypothesis predicts "less stress and annoyance" with SL. The majority of the drivers seemed to agree on this, at least not being influenced by the SL. Some drivers, however, claimed that they would have to plan their travelling more carefully, i.e. allocate more time for the trip. Seven out of 25 drivers in one of the groups claimed this. As the actual time increasement is very small this primarily indicates a dissatisfaction with the risk of having to use more time, even though small.

* Regarding the drivers' view on the effects of an SL-system on the interaction with other road users, one third of the answers regarding interaction with other car drivers was positive only while two thirds of the answers regarding interaction with vulnerable road users were positive only. The answers could be interpreted as if the drivers meant that traffic would be 'less competitive'.

* Regarding "disturbances in the normal driving behaviour" more than half of the drivers thought it was frustrating not being able to accelerate.

To conclude: The studies seemed to give a fairly good view on how drivers would react and behave on an SL. There seemed to be no major changes of behaviour in a negative way, e.g. there were only very small tendencies to some kind of risk compensating behaviour (somewhat higher speeds at the last part of the entry to intersections). The conflict studies did not either support the idea of increased risks. On the contrary, the number of conflicts dropped to zero in our test-rides. Even though small numbers, this was one clear positive indication from a safety point of view.

The study showed that it was very worth-while carrying out a study of this kind, at this early stage. It did sufficiently support the concept as such and produced strong arguments for a larger, long-term study of the SL. This study will produce a perfect basis for that new study, both from a methodological point of view and from the point of view that the results gave clear indications for the design of the new study as it showed what aspects in driving that might create problems from a safety point of view. More focus should be put in studying these aspects in order to make predictions of changes more reliable.

It seems, however, already clear that there is a great safety potential in the concept. It seems also clear that the introduction of SL in a large scale would not produce any major disbenefits or any 'new hazards' of such a magnitude that it would endanger the benefits. This is at least true for urban conditions.

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