

SPEED LIMITS AND ENFORCEMENT

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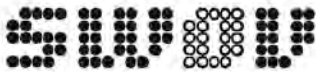
speed limits and enforcement

Speed limits and enforcement by police supervision

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Objective and subjective risk of detection

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Preface

Early in 1966 the Minister of Transport and Waterways of the Netherlands requested the Institute for Road Safety Research SWOV to investigate the effect of various kinds of speed limits on traffic safety outside built-up areas.

The study also served to determine the effect of police supervision on the enforcement of speed limits. The investigations covered the years 1966 to 1969, and the results are discussed in SWOV (1971).

The above report emphasises the need for further research concerning the enforcement of speed limits. The question whether long-term measures with regard to limiting speed have any effect are closely related to supervising the enforcement of such measures, while for answering this question a certain amount of information is required which should provide sufficient insight into the degree of supervision which would ensure optimum effect from the measures. Optimum effect is considered to be achieved when increased investment in inspection begins to show a declining efficiency (surplus yield) in numbers detected.

This brochure sets out two closely related studies. The first report, prepared by J.H. Kraay, research sociologist, and P.C. Mattie, is based on a literature study concerning studies of the effect of police supervision on the enforcement of speed limits. The second sets out a framework of concepts based on the chance of detection within which a further study is to be developed. It was drawn up by J.H. Kraay, research sociologist. Both reports were prepared for the OECD Research Group S6: The effects of the enforcement of legislation on road user behaviour and traffic accidents.

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Speed limits and enforcement by police supervision

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1. Introduction

1.1. Road traffic legislation and administration

The general view in our countries is that the elements of road traffic administration, such as road engineering, use of traffic signs, influencing of road behaviour, should be based on legislation. It should be borne in mind that such a basis indicates only that administration is and must be subject to verifiable rules formulated in legislation. The legislator creates the legal foundations for application of all policy elements, but this does not imply that the elements are actually applied and compared.

The legislator proceeds from a principle of justice which becomes operative immediately regulations are offended against. Such offences may affect third parties. The principle of justice requires that these offending the rules receive the blame. In a society where technology and mass services and communications are constantly growing in importance, it will become increasingly difficult to apply the principle of individual guilt. The significance to road safety of offences and traffic offences as exponents of this principle will thus have to be re-examined.

1.2. Offences as 'causes' of road accidents

Road users, as the sole acting element, are often held largely responsible for accidents. Accident statistics constantly suggest that nine out of ten traffic accidents are due to avoidable errors by road users.

Present road accident statistics are inadequate for examining the real influence of offences on road safety. Firstly because there is insufficient information on the total number of traffic offences, especially the proportion not involving accidents. Secondly because if the question of blame is treated as the principal aspect, this will always fall upon the road user as the sole element in the system of road, vehicle and individual capable of acting in a legal sense.

When errors occur in a road user's observations, decisions and actions which may result in accidents, the road user is a necessary but not sufficient condition. The fact that errors can be established in a road user's behaviour does not mean that there are no circumstances beyond his control (Griep, 1970).

1.3. Offences as accident 'predictors'

Many people no doubt wonder what relation there is between offences and involvement in accidents. In research by Edwards and Hahn (1970), 308 motorists were followed and filmed for five minutes on an urban route. The average number of offences proved to be 9.18, while the average number of different categories of offences was 3.90. Edwards and Hahn made a sub-division into motorists who had caused one or

more accidents, with or without blame in preceding years. Based on the available data they could find no relation between offences and accident prediction. Since Walbeehm (1969) among others also showed that accident-prone road users cannot be pointed out, one should be cautious about saying, for instance, that 'offenders are dangerous drivers'.

1.4. Enforcement and offences

Road-traffic supervision is still largely unprogrammed with regard to safety. Much is left to the enforcing or reporting officer's initiative.

Traffic regulations differ, inter alia, in the degree in which they are enforceable. This may easily affect the enforcement of regulations which, though difficult to carry out, are not necessarily less important to road safety.

In view of this it is often impossible to establish a correlation between offences and accidents. On the one hand there are no cases in which an offence is not accompanied by accident involvement. On the other hand, an offence will be alleged in many cases. The (widely-framed) Article 16 of the Road Traffic Regulations in the Netherlands providing that drivers must take action only if this is possible 'without endangering or interfering with other road users or causing damage' provides ample scope for this.

1.5. Criteria for regulations concerning road behaviour

If such regulations are to perform their function of safe traffic control, they must meet the following requirements:

1. They must give information, i.e. be understandable, relate to specifically described conditions or acts, and permit clear interpretation.
2. They must be non-contradictory, i.e. not clash with other regulations in their operation.
3. They must possess validity, i.e. be significant for safe traffic control; not superfluous or incomplete.
4. They must be capable of being obeyed by road users and enforceable by the police. Obedience may be physical or mental. Mentally, the regulations must not cause the individual road user too much discomfort.

If regulations for road behaviour do not meet these criteria, they may face road users with problems, thus causing greater legal uncertainty and being detrimental to road safety.

2. Speed limits

Fast driving is regarded again and again as having an important causal relationship with various kinds of accidents. This may give all the more reason for anxiety, because the average speed of Dutch motorway drivers rises by about one kilometre per hour each year, while traffic densities are also increasing (principally because of the rapid growth in the number of cars on the road).

2.1. American and European regulations

In the U.S.A., speed limits do exist since 1939. Limits are fixed by the individual States and regularly adjusted to changing conditions, such as higher speeds, improved roads, etc.

In the Netherlands a general speed limit of 50 km/h in built-up areas was introduced in November 1957. This may have had a slight effect on the number of fatal accidents in the year that followed. But other factors may have been involved (including the consequences of the Suez crisis). Since then a number of local authorities have introduced speed limits over 50 km/h for road sections outside the built-up area. Some provincial authorities have also introduced speed limits, generally 70 to 90 km/h, for specific road sections. Speed limits were also set for national highways.

Some European countries have general speed limits, but more have specific limits applying on a small scale. A survey of investigations into speed limits in Europe is given in OECD (1972).

2.2. Backgrounds

The idea behind speed limits can be summarised as follows.

1. Speed limits reduce excessive speeds. The accident hazard, and especially the severity of accidents, greatly increases at very high speeds.
2. Speed limits reduce speed differentials. It can thus be claimed that there will be less overtaking, which as a rule is comparatively dangerous. There will also be less risk of traffic with greatly differing speeds meeting.

2.3. Terms of reference

In 1965, the Minister of Transport and Waterways in the Netherlands requested the Institute for Road Safety Research SWOV to establish general criteria by reference to which road authorities could decide whether to introduce speed limits on road sections under their control.

The SWOV research was a before-and-after study. The test period covered over two

years (from 1966 to 1968). About 750,000 speed measurements were made, and all recorded accident statistics for the roads in question were collected (SWOV, 1971). As part of the research, it was thought advisable to examine the extent to which the speed limit would be observed if police supervision were stepped up. Hence, the National Police (General Road Patrol Section) and the Municipal Police of Ede checked speeds with a radar van for three months on about 28 km of road between Maarsbergen and Oosterbeek. These police checks were separate from the speed measurements conducted by a department of the Ministry of Transport and Waterways.

3. Characteristics of road behaviour

Apart from the legal and judicial standpoints, the problem can also be approached from the aspect of behavioural science, since regulations and actual behaviour should be (positively) related.

3.1. Speed limit perception

A speed limit is not always deliberately broken. The road user may be given too much or too little information. He may also be unable to comply with the regulations (particularly minimum speeds).

There is a tendency for extremely high and extremely low speeds to have a negative effect on the road user's observation of traffic signs (Häkkinen, 1965). This distortion of perception must not, says Häkkinen, be looked upon as an absolute upper limit to perceptive capacity. Since variables such as having of a driving licence, sex and annual mileage do not affect perceptive capacity, Häkkinen assumes there is a correlation with attitudes towards driver responsibility or towards traffic regulations in general. On motorways in the Netherlands speed-limit signs are repeated after every access road. There may be a danger of the sign being overlooked because the driver's perception being overburdened by the complex conditions (merging and overtaking traffic). Investigations into minimum speeds with high traffic densities in America (Wingerd, 1968) showed that 25% of speeding drivers stated they had not seen the signs. Where there was only one speed limit sign, Häkkinen (1965) even found 67%!

The existence of noticeable police supervision draws most road user's attention to it; 95% of a test group of road users recorded the presence of a stationary police car on the roadside (Syvänen, 1968). Attention is even taken up so much by this as to detract from the observation of traffic signs in the immediate vicinity of the police car. But perception is better if a police car is stationed a given distance (about 200 metres) ahead of the speed limit sign.

Proper location and good visibility of traffic signs can thus be stated as conditions for justifying legal enforcement of a regulation.

3.2. Road users' speed habits

A motorist used to his car can reduce speed by a certain factor, but cannot reduce it to a prescribed speed without looking at his speedometer (Salvatore, 1967, and Klebelsberg, 1969). Moreover, drivers actually look at their speedometer less than they think they do under fairly complex conditions (roundabouts, junctions, etc.), while they look at them more under simple conditions (Denton, 1967). If a driver has to adjust his speed from high to lower and lower levels, his subjective assessment of his speed is definitely unreliable.

It is striking that speed limits should tend to influence road users regarding the prescribed standard indirectly rather than directly. Klebelsberg (1969) found motorists to respond to a speed limit on a motorway not so much by moving towards the prescribed limit, but primarily relative to their chosen original speed. This means that they do not regard the restrictions imposed by the speed limit as an objective indicator of the threshold value, but interpret it subjectively.

There are indications that a big proportion of road users sometimes break speed limits and that a very small percentage break them regularly. American research (Ogawa et al., 1962) gave the following figures. On roads outside built-up areas with speed limits of 56 to 109 km/h, 52% of road users broke the limit at least once, 38% more than twice, 20% more than three times and 5% more than five times. This was established from measurements at a number of points on given road sections.

3.3. Attitudes to speed limits

Even though attitudes to road safety are less relevant than behaviour under actual driving conditions, the road user's opinion may be important in formulating decisions.

In the Netherlands, ICO (1969) investigated personal opinions of speed limits by means of domestic research. Nearly 74% of the respondents were in favour of a maximum speed and even 92% in favour of a minimum. But as to what the maximum speed on motorways should be, two-thirds thought 100 km/h unacceptable. (SWOV research showed in fact that on average a far smaller proportion, up to about 40%, drive faster than 100 km/h). Perhaps the results of the ICO research are partly explained by the fact that people are sensitive about lengthening their journey time. Häkkinen's (1965) grounds for this assumption are that 16% of the respondents stated that a speed limit affected their travelling time. Another possible explanation is that speedometers generally show higher speeds than those actually measured, for instance with radar equipment.

As regards expectations of observance of speed limits, the ICO report states that only 18% of the respondents thought a speed limit (with sanctions) would be observed, while 15% thought this would be so with a recommended speed.

There is clearly a discrepancy between the road user's attitude to the speed limit and his actual behaviour. If the regulation (speed limit) is to be widely obeyed, this discrepancy will have to be reduced.

4. Enforcement

4.1. Objective and subjective chance of detection

Road users on the whole have little experience of sanctions and thus have hardly any knowledge of the objective chance of detection. Their own interpretation thus means much more to them.

The SWOV research showed that with constant use of a radar van the chance of detection when driving faster than 125 km/h (with a 110 km/h speed limit) is not more than 1 in 4. The gap is due, among other things, to the limitations of the measurement equipment. If a driver is speeding but does not reach 125 km/h, the risk of being reported is nil owing to the margin allowed for in these investigations in order to offset the inaccuracy of the measuring equipment.

The chance of sanctions for individual road users prove to consist of:

- a. the chance of being stopped for breaking speed limits;
- b. the chance of prosecution after being stopped;
- c. the chance of a penalty after prosecution;

If the subjective evaluation of these factors is very low, measures aimed at changing the objective facts will have more effect on subjective evaluation until the optimum situation is reached. At the same time the assessment of the likely penalty after prosecution (d) plays a part in the aggregate effect. The aggregate effect, expressed as road behaviour, is a rather complex product of these four subjective values. This means that if one of these subjective values is nil, the product will be nil, too.

Assuming the impossibility of increasing the objective chance of detection by adjusting the level of enforcement, alternatives may be sought. One possibility is electronic systems, for instance with measuring boxes on motorways at 5 km intervals. A given number of measuring devices should be spread in both place and time. A system of this kind has been operating in the Netherlands for some months near railway level crossings equipped with automatic flashing lights.

The advantage of this increased objective chance of detection is that familiarity with the system also increases the subjective chance. Langemeyer (1970) thus correctly believes that it is not so much the general preventive effect of a given punishment which is the deterrent as the actual risk of being punished. It should also be remembered that the above factors influence different phases of behaviour. The effect of police enforcement can be subdivided into preventive, redressive and repressive aspects.

4.2. The effects of enforcement

4.2.1. Preventive effect

Knowledge or announcement of intensive police checks, whether or not combined with the road user's own observation of these, can influence behaviour so that certain offences are avoided. The actual preventive effect is determined by the road user's evalu-

ation of the situation. He assesses whether the advantages are bigger or smaller than the disadvantages. Relevant factors are the severity of the penalty and the loss of time through keeping to the limit, and also his understanding of the safety relationships involved. As a rule, road users will be annoyed by any new regulation which they regard as inconvenient and non-functional.

The extent of the preventive effect is difficult to measure; so far, no results are known.

4.2.2 *Redressive effect*

This is a question of the road user's behaviour changing immediately on the spot. It may relate to either punishable or non-punishable behaviour. It must not be expected to cover more than a narrow range, i.e. the distance from which enforcement is perceived to a point a few kilometres further.

Redressive behaviour depends, inter alia, on how noticeable the enforcement or the measuring equipment is, the possibility of correcting one's own actions, the conspicuousness of one's behaviour compared with that of other road users, the severity of the penalty, the risk of detection and the evaluation of these aspects.

According to Biehl and Fuhrman (1969) and American research (See 4.3.2.) a certain percentage of motorists succeed after perception in reducing their speed at 50 km/h by about 10%. About five kilometres further on this effect vanishes (Smith, 1963) and they return to their original speed.

4.2.3 *Repressive effect*

The repressive effect of enforcement relates to the consequences of the individual sanction, prosecution. By fining the offender (intimidation) it is hoped he will not offend next time. Langemeyer (1970) presumes that punishment does not help if the offender does not realise that he has acted carelessly. This presumption means that an empirical connection must first be proved between fast driving and accident involvement. Next, this information must be transmitted to the road user. In the case of speeding, therefore, the driver must realise that his speed increases the danger. It is difficult to transmit the proper information to this effect to the driver. His own perception and evaluation of road behaviour is the major factor in his actions. His own evaluation also tends to be that he drives better than the average road user (ICO, 1969).

Besides, excessively high or low penalties more or less arbitrarily applied may increase legal uncertainty. If the road user realises that breaking the speed limit is a dangerous act with a commensurate penalty, the chance of his keeping to speed limits will be greater. Yet if, contrary to this, the severity of the penalty is not specifically related to road safety, there may be a greater risk of the offender feeling antagonistic towards the police and definitely so, if both enforcement and punishment are sensed to be clearly selective. Ultimately, therefore, this is again a matter of the road users' evaluation.

As the foregoing shows, the vital question is the road users' evaluation. Road users' perception can be increased, for instance by locating traffic signs properly, correctly locating stationary enforcement, by familiarity with and imposition of penalties. Road users' evaluation can be made more objective for instance by pointing out how little time they gain by speeding, and how much bigger the risks are that they take.

4.3. The form of enforcement

Traditional police detection methods differ according to form and extent to which they stress preventive, redressive and repressive effects. The form of police supervision will obviously influence road users in different ways. Apart from the fact that enforcement is not usually spread over time and place and some road users are therefore more or less familiar with police practice, enforcement may also be carried out with noticeable moving or stationary police cars (for instance with visible measuring devices) or inconspicuously (with concealed measuring devices, infra-red cameras).

4.3.1. *Enforcement according to time and place*

The chance of detection for speeding is known to be very slight. According to Cramton (1969) the chance under American conditions is 1 in 7600 cases of speeding offences. Under Dutch conditions, drivers are moreover often aware of the places of checking (for instance roads entering and leaving urban areas). Besides, the police usually check only when the weather is reasonably good. All this means that only a specific category of road users are supervised, and some of these are familiar with police practice and drive accordingly.

4.3.2. *Noticeable enforcement*

It is obvious that the more noticeable the enforcement is, the more the speed limit at the point of enforcement will be adhered to.

American research (Smith, 1963) indicates that conspicuous police checks in the form of stationary cars on the roadside significantly reduce average speed. The greatest effect is observed if the police car is on the side of the motorway with the greatest density. The research showed that the speed of the traffic in the opposite direction decreased more. The percentage of speeding drivers fell from 40% to 6%, while the decrease on the side where the equipment was located was from 40% to 15%.

With a speed limit of 35 m.p.h., Baker (1954) found a fall of 10% in average speed if a police car stood on the roadside while measurements were being made immediately after it. The same 10% drop was found by MacKay (1968) if a radar van was stationed in a conspicuous position. Both MacKay and RRL (1965) even found a decrease of nearly 20% in average speed with a combination of radar van and police car.

If a conspicuous police car drives along with the traffic, Smith (1963) believes this to cause an even greater decrease in average speed than if police cars stand on the roadside. It is also interesting to note that this research showed that the effect was still observable for at least five kilometres further on.

SWOV research showed that the percentage of speeding drivers (the percentage over 110 km) on a given section of the road in question (Veenendaal-Maarsbergen) fell from 29% to 19% when police enforcement was increased. The percentage of very fast drivers (over 125 km) even fell by half, from about 7% to about 3.5%.

A speed limit is apparently a standard which road users do not readily adopt. It is thus more likely that they keep to it when there are obvious checks; such a check may even have the effect of a bogeyman as Smeed (1964) suggests. A given road was patrolled on alternate days, and a significant (lower) difference was found in the percentage of vehicles driving fast on those days. The same applied on roads with no speed limit.

4.3.3. *Unnoticeable enforcement*

Biehl and Fuhrman (1969) found, upon unobtrusive measurement with photoelectric equipment, that the average speed was 10% above the 50 km/h limit. During radar control by a (noticeable) police van, the average speed was below 50 km/h.

If unnoticeable checks are intended to summon more offenders with a view to influencing future behaviour, some comment is called for. Since in such cases, some weeks usually elapse before the offender hears he has been reported he will to some extent feel he has been 'had' by this method of reporting. Consequently, he is likely to feel more antagonistic towards the police in general, and in future situations is not likely to cooperate with them. It is also obvious that such unnoticeable checks (notification after the event owing to which the offender may not so readily remember the offence; the small chance of detection, shown by SWOV research as 1 out of the 4 drivers exceeding 125 km/h (when the limit was 110 km/h), will take a long time to influence attitudes to speed limits.

4.4. **Results of empirical research into relationship between enforcement and road safety**

The foregoing has shown that a speed limit greatly influences road behaviour on motorways if its enforcement is stepped up. Assuming such enforcement exists, the effect of speed limits on safety can now be examined. Most research on this matter comes from the United States, which has had experience of speed limits outside built-up areas since 1939.

When limits are introduced the usual procedure is to give considerable publicity to the new regulations by pointing out how dangerous and criminal speeding is. When the regulation is introduced, the police force is extra active on this point.

Research in Connecticut in 1955 and 1956 showed a decrease of 12.3% in the number of fatal accidents, with a limit of 65 m.p.h. But Campbell and Ross (1968) contested these conclusions and said that, on the basis of graphic observation and statistical consideration for the period 1951-1959, the decrease in the number of fatalities had not been scientifically proved. The research had not allowed, for instance, for the regression effect in the accident pattern in the course of a number of years.

Research in Wisconsin (Shumate, 1958) showed a decrease in the number of accidents with intensified police enforcement (1 police unit per 20 to 40 km motorway). An increase in enforcement above this level had no greater effect on accidents either in frequency or severity. Michaels (1960) criticised Shumate's investigations, especially as regards the statistical processing of the material.

Research by Munden (1966) even showed a fall of 25% in fatal accidents. The numbers of accidents concerned were small. In this case, enforcement was increased 3.5 to 13 times the original level and the road sections on which the reduction in fatal accidents occurred were only 2 to 7 km long. The road was a single carriageway where the limit was 50 km/h. The author suggests that the decrease in the number of accidents was not due to the speed limit, but to generally improved behaviour.

The SWOV research into the effect of increased enforcement showed that speed differentials on the roads investigated decreased fairly constantly by 5% to 10%. Theoretically, this should result in 5% to 10% fewer cases of overtaking, and greater safety. But there is still the methodological problem of proving a really significant difference. To sum this up, investigations which indicate greater safety can be challenged as re-

gards their scientific value. The validity and reliability of the information and its statistical processing are, to say the least, far from perfect. The most common errors in this research are:

- a. failure to allow for regression of the accident curve after a high peak owing to incidental factors;
- b. if a trend is in fact allowed for in accident patterns, it is justifiable to assume that the same trend will exist in the (often short) study period as in a longer period;
- c. the sample is often too small;
- d. failure to include control roads in the investigations;
- e. giving publicity to the investigations, which may influence road users' behaviour in the period concerned, thereby distorting the findings.

5. Conclusions

A number of conclusions are summarised below, reflecting the present position of scientific research into speed limits and their enforcement.

1. The number of investigations dealing with enforcement and speed limits is still fairly small.
2. On the whole, the scientific value of research so far is, to say the least, dubious.
3. Speed limits substantially influence road users' actual behaviour only if their enforcement is increased.
4. Little is known about the preventive, redressive and repressive effect of intensified enforcement of speed limits.
5. Since the important factor is the road users' perception and evaluation, these two aspects will require further study.
6. Research so far has not produced sufficient scientific evidence that speed limits have a positive effect on safety.
7. The speed limit appears to be a standard of conduct that is difficult to adopt, even in America which has had many years' experience of such limits.
8. Enforcement influences road users' actual behaviour in the form of less speeding, even if there is no speed limit; this seems very much like the effect of a bogeyman.
9. Speed limits cannot be enforced with the present form and size of police forces; anyway, like all regulations of behaviour, speed limits have to conform to the requirements as mentioned in para. 1.5; in this way other forms of enforcement would seem more suitable.
10. If there is an empirical relationship between speeding and increased danger, a more effective way to improve road safety, bearing the above conclusions in mind, is to increase the subjective risk of detection rather than the objective risk.

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1. The risk of detection

1.1. General

Police enforcement produces three effects: a preventive, a redressive and a repressive effect (see also page 14)

a. *Preventive effect*

The ultimate object of statutory measures and their enforcement is to modify the behaviour of road users to such an extent that a safe and efficient traffic system is obtained, i.e. prevention. The extent of the preventive effect is difficult to measure, and very few results are known up to the present.

b. *Redressive effect*

This relates to the immediate, on-the-spot change in the conduct of the road user. The road user will change his behaviour on account of the conspicuousness of any particular supervision. It would be wrong to expect more from this effect than that it has a limited range: the area in which perception of that particular supervision occurs, up to a point some time farther away. The results of a few surveys suggest a reduction in average speed and in the distribution of speeds over a range of several hundreds of metres before the supervision up to a maximum of six kilometres beyond it.

c. *Repressive effect*

The repressive effect of police supervision relates to the results of the individual sanction, the prosecution. By punishing the offender with a fine in the case of an offence (intimidation) or imprisonment in the case of a crime (exclusion) one hopes to prevent the person in question from repeating the offence or the crime. The hypothesis holds good only if the delinquent realises that his action has been imprudent. So far there has been only little research in this field in relation to traffic.

Observation. The assumption that the delinquent realises that he has acted imprudently is refuted in traffic by the fact that so many have also committed many traffic offences. If it is true that the majority of road users regularly infringe a traffic regulation, the offence is regarded as a folk crime. The traffic legislation in question is not taken seriously, and a new standard of behaviour is created. Once the new mode of conduct has assumed a fixed, defined pattern, it will be difficult by means of sanctions to bring about a return to the original behaviour as prescribed by law. For the road users do not take the traffic regulation seriously, and if they are fined, this is construed as bad luck.

There is a strong impression that many traffic regulations do indeed come within the category of folk crimes, and this hampers enforcement. This notion is strengthened by the fact that in most cases the risk of detection is very slight.

Insufficient attention has so far been paid to the objective and subjective aspects of the risk of detection (see also page 14). There is a strong feeling that by manipulating these

objective and subjective aspects of the risk of detection, it is quite possible to influence traffic behaviour in such a way that instead of the bogeyman effect (redressive behaviour) produced by police supervision, a more preventive effect is achieved. Moreover, it would seem advisable to differentiate between a collective risk of detection and an individual risk of detection, for if the individual road user is to make an estimate of the risk of detection, for if the individual road user is to make an estimate of the risk of detection, he will do so on the basis of his own personal and vehicle characteristics.

1.2. Collective and individual risk of detection

By collective risk of detection is meant the average risk of road users being detected, for instance, in exceeding the speed limit. Hence, there is a relation between the number of offences and the number of detections, say, an average of 1 detection for every 500 offences.

By individual risk of detection is meant the risk of detection run by the individual road user who in a particular vehicle covers a certain route, is or is not familiar with the place, time and level of supervision, drives attentively, etc. This individual risk of detection can also be expressed in the ratio between the number of contraventions and the number of detections.

These collective and individual risks can be determined, for instance, as follows: Along a particular stretch of road speeds are measured inconspicuously at a large number of places. On motorways this could be done by measuring from flyovers in the direction of the traffic. In addition, speeds are checked along the road (conspicuous measurement) and drivers exceeding the speed limit are fined. Along the road experiments can be conducted with several levels of enforcement.

The collective risk of detection can then be determined by setting off the number of drivers exceeding the limit, detected by inconspicuous measurement against the number of drivers exceeding the limit, detected by conspicuous roadside checks.

The individual risk of detection can be determined by recording the registration numbers of the speeding vehicles detected by conspicuous measurement over the entire stretch. In this way an offence is defined as exceeding the speed limit at one of the measuring posts.

1.3. Objective and subjective aspects

There is an objective and a subjective side to both the collective and the individual risk of detection. By objective is meant the actual risk of detection, whereas subjective relates to the individual evaluation of that objective risk.

Since, generally speaking, the objective collective risk is very slight at present, and is difficult for the road user to assess, this risk is only a minor factor in his road behaviour. For certain individuals or categories of road users the objective individual risk is greater than the objective collective risk, and as such will be assessed more accurately by the person in question. As these two objective aspects of the risks are very minor, the subjective evaluation of these risks by the road user will play a much bigger part in decision-making. Especially the subjective evaluation of the individual risk of detection, which conveys more to the individual road user, will govern his ultimate action.

2. Subjective individual risk of detection

The next question is how this subjective individual risk of detection is essentially arrived at.

Generally speaking, the subjective individual risk of detection is always concerned with individual perception and evaluation of the subject in question. Relevant for the driver's perception of offences are visibility, conspicuousness and recognisability of traffic signs in his immediate surrounding.*

The considerations entering into the road user's evaluation are of two categories:

a. *Considerations of safety*

In the case of speed limits, the road user will select a speed which he considers to be just short of dangerous. If the speed limit is below this 'personal' safety limit, the road user may evaluate the prescribed rule of conduct in one of the following ways:

- a it is an acceptable rule of conduct;
- b it is an indication for him to revise his personal safety standards;
- c it is a senseless restriction of freedom;
- d it is an effective measure for others.

From evaluations a and b voluntary observance is to be expected; not so from c and d. If there is no enforcement, or the level of enforcement is too low, it is to be expected that the imposition of a speed limit will, admittedly, result in only slight changes in speeds, which may reduce the scatter of the speed differential, but that this rule of conduct will be devalidated especially for the category of road users who habitually exceed the speed limit. It is essential to know if such a category exists and how large this category is, and what shifts occur in it.

b. *Considerations relating to the penalty in the event of offence*

If the risk of incurring a penalty is examined in regard to the individual road user, it will be found that this risk consists of:

- a the chance of being stopped when exceeding speed limits;
- b the chance of prosecution after being stopped;
- c the chance of a penalty after prosecution.

If these factors are subjectively rated very low, any measure aimed at changing the objective facts will have more effect on the subjective evaluation up to the point where the optimum is reached. The evaluation of the penalty upon conviction (d) also influences

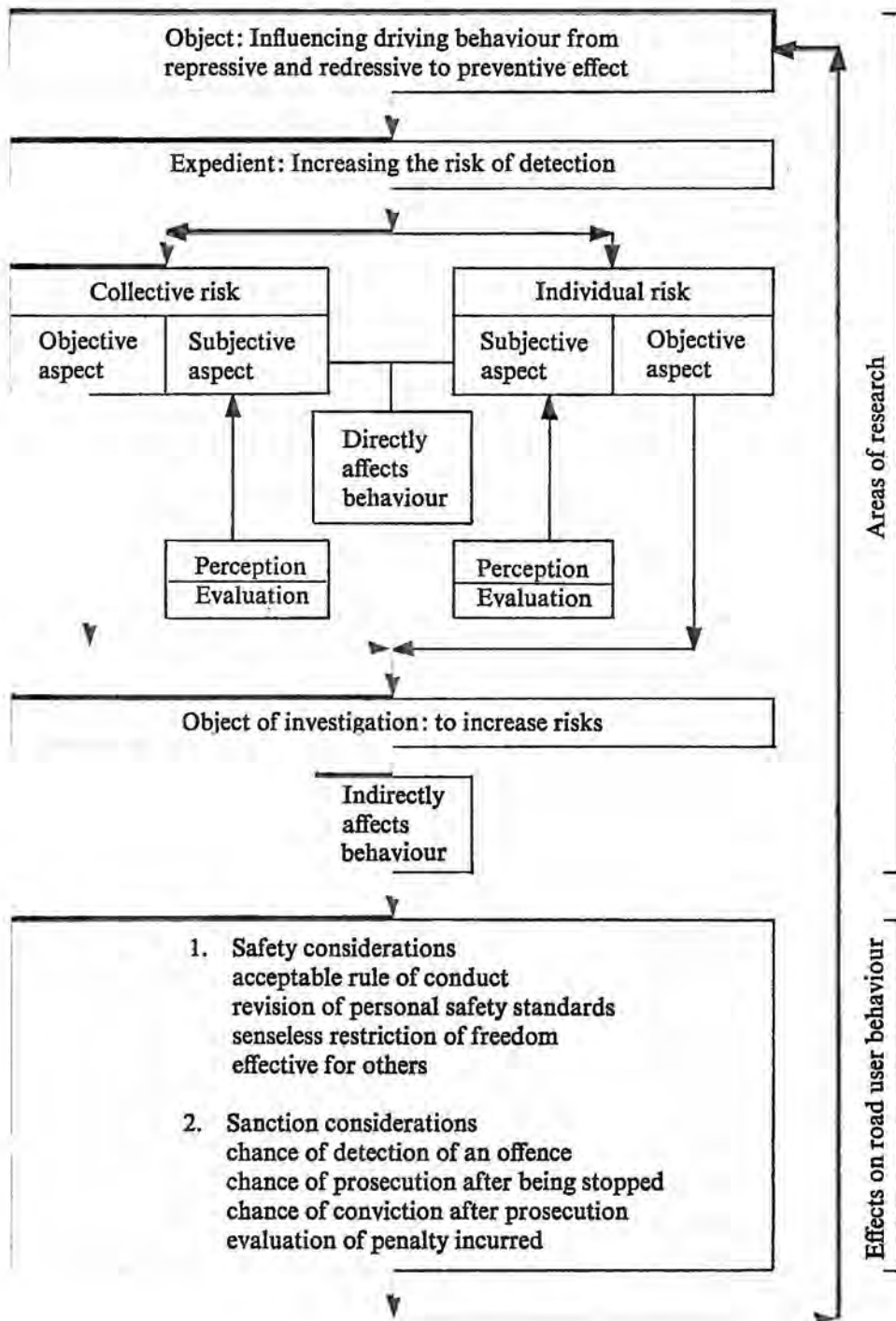
**Visibility*: detectability under conditions of certainty as to time and place of object, while no side-tasks are being performed.

Conspicuousness: detectability under conditions of uncertainty as to time and place of object, while performing side-tasks.

Recognisability: detectability of attributes defining the class of objects to which it belongs (when the object as such is perceived).

the total effect. The total effect, expressed in driving behaviour, is a fairly complex product of these four subjective values. This implies that if one of these subjective values is nol, the product will likewise be nil (see also page 14).

With automatic detection (e.g. by photograph) a, b and c are equal, so mainly a and d will be concerned in the evaluation.



3. Ways and means of influencing traffic behaviour

In theory there are four ways of increasing the risk of detection, namely by influencing the objective collective risk, the objective individual risk, the subjective collective risk and the subjective individual risk. There is, of course, a close relationship between these risks. If the objective collective risk is increased, the objective individual and, later in time, the subjective individual risk, too, will change.

Increasing the subjective risks will have a direct and early influence on road behaviour; influencing the subjective individual risk being the most effective way of doing so. A plan of research based on this will require a great deal of (possibly fundamental) preliminary investigation. It will have to be ascertained in what areas the road user can be most effectively influenced: A detailed list of what has already been done in advertising psychology and other comparable fields would be a useful aid in designing what will ultimately be a subjective (probability) model.

The alternative approach to influencing behaviour is by increasing the objective risks. Here, too, it will be necessary first to list the theories on these risks, and to determine what these risks are by category of road. The greatest effect in regard to influencing behaviour will be achieved by increasing the objective individual risk. If this should prove impracticable, one could opt for increasing the objective collective risk (see table).

4. Expected results of enforcement

If the level of enforcement of i.e. the speed limit is greatly increased, the analytical distinction between the four types of risk will vanish. It is, therefore, to be expected that the objective individual risk will approximate to the objective collective risk of detection; this will likewise apply to the subjective risks.

In regard to the considerations of sanction it is probably true to say that the risks of detection in the case of offences will increase sharply.

Owing to the sharp increase in the risks of detection the evaluation of the penalties incurred will change, in as much as the occasional payment of fines in cases of 'bad luck' will become a regular payment on committing an offence for the offender will be familiar with the functioning of the system.

In regard to considerations of safety it is to be expected that the notion that the measure taken is effective for others, will be superseded by a revision of personal safety standards, thereby becoming an accepted rule of conduct. This reasoning also applies (though to a lesser extent) to those road users who regard the measure as a senseless restriction of freedom.

Ultimately it should be possible to influence behaviour in the sense that redressive effects will be increasingly replaced by preventive effects, and that i.e. speeding offences will be lifted out of the sphere of folk crimes.